KENWOOD

# SSB TRANSCEIVER

# Model TS-900

## OPERATING MANUAL

# TS-900 OPERATING MANUAL

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# TS-900 SPECIFICATIONS

| | |
|---|---|
| FREQUENCY RANGE | 80 meter band — 3.5 to 4.0 MHz<br>40 meter band — 7.0 to 7.5 MHz<br>20 meter band — 14.0 to 14.5 MHz<br>15 meter band — 21.0 to 21.5 MHz<br>10 meter band — 28.0 to 28.5 MHz<br>28.5 to 29.0 MHz<br>29.0 to 29.5 MHz<br>29.5 to 30.0 MHz<br>WWV 15.0 MHz (Receive Only) |
| MODE | SSB, CW, or FSK |
| POWER REQUIREMENTS | 120 VAC (or 240 VAC), 50/60 Hz (with PS-900)<br>13.8 VDC (with DS-900)<br><br>Receive: Less than 40 watts (with heater off)<br>Transmit: Less than 410 watts (at 14.175 MHz in the CW mode) |
| PLATE POWER INPUT | More than 300 watts PEP on SSB, more than 200 watts DC on CW, and more than 100 watts on FSK. |
| POWER OUTPUT | 150 watts PEP nominal into 50 ohms for SSB,<br>100 watts nominal into 50 ohms for CW,<br>50 watts nominal into 50 ohms for FSK. |
| AUDIO INPUT | High impedance microphone or phone patch. |
| AUDIO OUTPUT IMPEDANCE | 8 ohms or 600 ohms. |
| AUDIO OUTPUT | More than one watt (with less than 10% distortion) into an 8 ohm load. |
| RF INPUT IMPEDANCE | 50 ohms. |
| RF OUTPUT IMPEDANCE | 50 ohms with SWR less than 2 : 1. |
| MATCHING PHONE PATCH IMPEDANCE | 600 ohms, receive output to phone patch, high impedance input to the transmitter. |
| FREQUENCY STABILITY | Within 100 Hz during any 15 minute period after warmup.<br>Within ±2 KHz during the first hour after 1 minute of warmup. |
| CALIBRATION ACCURACY | Within 2 KHz across the frequency range after calibration at zero. |
| BACKLASH | Not more than 400 Hz when the dial is advanced from zero to 500 and returned to zero. |
| KEYING | Break-in CW with sidetone provided. |
| AUDIO FREQUENCY RESPONSE | 400 to 2500 Hz, within –6 db. |
| CARRIER SUPPRESSION | Carrier better than 45 db down from output signal. |
| SIDEBAND SUPPRESSION | Unwanted sideband better than 40 db down from the output signal. |
| HARMONIC RADIATION | Better than 40 db down from output signal. |
| IMAGE RATIO | Image frequency better than 50 db down from the output signal. |

| | |
|---|---|
| **IF REJECTION** | First IF frequency 45 db or more down from output signal. |
| **RECEIVER SENSITIVITY** | 0.5 microvolts for a 10 db signal + noise/noise ratio. |
| **RECEIVER SELECTIVITY** | SSB and FSK – 2.2 KHz bandwidth (6 db down)<br>4.4 KHz bandwidth (60 db down)<br>CW – 0.5 KHz bandwidth (6 db down)<br>1.5 KHz bandwidth (60 db down)<br>(with optional CW filter installed) |
| **CALIBRATOR** | Built-in 100 KHz and 25 KHz crystal oscillator. |
| **RIT** | The receiver incremental tuning control can vary the receive frequency ±2 KHz or more. |
| **RTTY** | The TS-900 has a built-in frequency shift circuit for FSK operation. The frequency shift is factory set at 850 Hz. |
| **NOISE BLANKER** | The built-in noise blanker is designed to reduce impulse type (ignition) noise. |
| **METERING** | ALC (Automatic Level Control)<br>IP (Plate Current)<br>RF (Relative Power Output)<br>HV (High Voltage)<br>S-meter |
| **VOX** | The TS-900 has a built-in VOX circuit with adjustable VOX gain and delay. |
| **MODULAR CONSTRUCTION** | All major electronic circuits are built on modular (plug-in) circuit boards. |
| **TUBE AND SEMICONDUCTOR COMPLEMENT** | 3 tubes (6LQ6 x 2 and 6GK6)<br>3 IC's<br>16 FET's<br>57 transistors<br>70 diodes |
| **SIZE** | 12.6" wide x 5.5" high x 12.6" deep |
| **SHIPPING WEIGHT** | 30.8 pounds |
| **WEIGHT** | 26.5 pounds |

# SECTION 1. INTRODUCTION

## 1.1 KENWOOD TS-900

The TS-900 is a highly sophisticated solid state amateur radio transceiver employing only three vacuum tubes. Operating on all amateur bands between 3.5 and 30 MHz, this unit is constructed modularly. All major electronic circuits are wired on easily removed or installed circuit board. The TS-900 includes many built-in features usually found as extras on other transceivers. Included in the equipment are a VOX circuit, a 100 KHz and a 25 KHz crystal calibrator, an RIT circuit, and an effective noise blanker. The TS-900 also includes automatic gain control (AGC), automatic level control (ALC), and provisions for break-in CW with sidetone.

Designed for operation on SSB, CW, and FSK, the TS-900 delivers more than 150 watts PEP output. The low power consumption of the TS-900, resulting from its solid state design, makes the transceiver ideal for portable and mobile operation. Any complicated electronic equipment will be damaged if operated incorrectly, and this transceiver is no exception. Please read all of the operating instructions before putting the TS-900 on the air.

## 1.2 REQUIREMENTS FOR OPERATION

### AC OPERATION

The TS-900 requires an external power supply for operation. For fixed station operation, the PS-900 AC power supply operates from any 120/240 VAC, 50/60 Hz power source capable of supplying 410 watts or more. This power supply has a built-in 8 ohm speaker. If a different power supply, other than the PS-900 or DS-900, is used it must be capable of supplying the voltage requirements described in Table 1 at the POWER SUPPLY connector.

**TABLE 1. Operating Voltages and Current Required by the TS-900**

| Pin Number | Requirements |
|---|---|
| 1 | −100 VDC at 8 ma. |
| 2 | AC switch control |
| 3 | 120 VAC at 120 ma. |
| 4 | 120 VAC at 120 ma. |
| 5 | 13.8 VDC at 510 ma. |
| 6 | 13.5 VAC at 3 amps. |
| 7 | 125 VDC at 40 ma. |
| 8 | 13.5 VAC at 3 amps. |
| 9 | grounded |
| 10 | 280 VDC at 70 ma. |
| 11 | 800 VDC at 340 ma. |
| 12 | −17 VDC at 20 ma. |

### DC OPERATION

The DS-900, designed for mobile operation, delivers the above voltages from a 12 VDC power source. This DC power supply does not have an internal speaker, therefore an external 8 ohm speaker is required.

### ANTENNA

Fixed Station — Any of the common antenna systems designed for use on the high frequency amateur bands may be used with the TS-900, provided the input impedance of the transmission line is not outside the capability of the pi-output matching network. The transmission line should be of the coaxial cable type. An antenna system which shows a standing wave ratio of less than 2:1 when using 50 or 75 ohm coaxial transmission line, or a system that results in a transmission line input impedance that is essentially resistive, and between 15 and 200 ohms will take power from the transceiver with little difficulty. If open-wire or balanced type transmission line is used with the antenna, a suitable antenna tuner is recommended between the transceiver and the feed line. Methods of construction and operating such tuners are described in detail in the ARRL Antenna Handbook, and similar publications. For operation on the 75 and 40 meter bands, a simple dipole antenna, cut to resonance in the most used portion of the band, will perform satisfactorily. For operation of the transceiver on the 10, 15, and 20 meter bands, the efficiency of the station will be greatly increased if a good directional rotary antenna is used. Remember that even the most powerful transceiver is useless without a proper antenna.

Mobile Station — Mobile antenna installations are critical, since any mobile antenna for use on the high frequency bands represents a number of compromises. Many amateurs lose the efficiency of their antenna through improper tuning. Remember the following points when using the TS-900 with a mobile antenna.

The "Q" of the antenna loading coil should be as high as possible. There are several commercial models available which use high "Q" coils.

The loading coil must be capable of handling the power of the transceiver without overheating. In the CW mode the power output of the transceiver will exceed 100 watts.

The SWR bridge is a useful instrument, but unfortunately it is quite often misunderstood, and overrated in importance. Basically, the SWR bridge will indicate how closely the antenna load impedance matches the transmission line. With long transmission lines, such as will be used in many fixed station installations, it is desirable to keep the impedance match fairly close in order to limit power loss. This is particularly true at the higher frequencies. The longer the line, and the higher the frequency, the more important SWR becomes. However, in mobile installations the transmission line seldom exceeds 20 feet in length, and a SWR of even 4 to 1 adds very little to power loss. The only time SWR will indicate a low figure is when the antenna presents a load close to 50 ohms, but many mobile antennas will have a base impedance as low as 15 or 20 ohms at their resonant frequency. In such a case, SWR will indicate 3 or 4 to 1, and yet the system will be radiating efficiently.

The really important factor in your mobile antenna is that it should be carefully tuned to resonance at the desired frequency. The fallacy in using an SWR bridge lies in the fact that it is sometimes possible to reduce the SWR reading by detuning the antenna. Field strength may actually be reduced in an effort to bring SWR down. Since field strength is the primary goal, we recommend a field strength meter for antenna tuning.

For antenna adjustments, the transceiver may be loaded lightly, using the TUN position instead of operating at full power output. This will limit tube dissipation during adjustments, and will also help to reduce interference on the frequency. In any case, do not leave the transmitter on for very long at one time. Turn it on just long enough to tune and load, and get a field strength reading. Start out with the antenna whip at about the center of its adjustment range. Set the VFO to the desired operating frequency and then adjust the PLATE control for a dip, and then the LOAD control. Then observe the field strength reading. The Field Strength Meter may be set on top of the dash, on the hood, or at an elevated location some distance from the car.

Change the whip length a half inch, or so at a time, retune the finals each time, and again check the field strength at the antenna. Continue this procedure until the point of maximum field strength is found. This adjustment will be most critical on 75 meters, somewhat less critical on 40, until on 10 meters the adjustment will be quite broad. After tuning the antenna to resonance, the finals can be loaded to full power.

## MICROPHONE

The microphone input is designed for high impedance (50 K ohms) microphones only. The choice of microphone is important for good speech quality, and should be given serious consideration. The crystal lattice filter in the transceiver provides all the restriction necessary on audio response, and further restriction in the microphone is not required. It is more important to have a microphone with a smooth, flat response throughout the speech range.

The microphone manufacturer's instructions should be followed in connecting the microphone cable to the plug. With many microphones, the push-to-talk button must be pressed to make the microphone operative. For VOX operation, this feature may be disabled, if desired, by opening the microphone case and permanently connecting the contacts which control the microphone.

## EXTERNAL SPEAKER AND HEADPHONES

Receiver audio output from the TS-900 is 1 watt at 8 or 600 ohms. The PS-900 AC power supply has a built-in speaker which is connected through the speaker cord. However, if an external speaker is desired for fixed station or mobile operation, simply connect it to the SPEAKER jack on the rear panel. The speaker may be any good 8 ohm permanent magnet type in the 4 inch or larger size.

Headphones should also be 8 ohms impedance. When the headphones are connected to the front panel PHONES jack the speaker is disabled.

# SECTION 2. INSTALLATION

## 2.1 UNPACKING

Remove the TS-900 and its power supply from their shipping boxes and packing material and examine them for visible damage. If the equipment has been damaged in shipment, save the boxes and packing material and notify the transportation company immediately. It is a good idea to save the boxes and packing material in any case because they are very useful for shipping or moving the equipment.

The following accessories should be included with the transceiver:

| | |
|---|---|
| 1 Operating Manual | 1 Alignment Tool |
| 1 Microphone Plug | 2 Plastic Extension Feet |

The POWER SUPPLY cord and fuses are included with the power supply.

## 2.2 OPERATING LOCATION

As with any solid state electronic equipment the TS-900 should be kept free from extremes of heat and humidity. Choose an operating location that is dry and cool, and avoid operating the transceiver in direct sunlight. Also, allow at least 3 inches clearance between the back of the equipment and any object. This space allows an adequate air flow from the ventilating fan to keep the TS-900 cool.

## 2.3 CABLING (See Figure 2)

### GROUND

Connect a wire from a good earth ground to one of the GROUND studs on the back of the transceiver. If a good earth ground is not available and the TS-900 is operated from an approved three-wire electrical system in the United States, the third or neutral wire will normally supply an adequate ground.

### ANTENNA

Connect a 50 ohm antenna feedline to the coaxial connector on the rear panel. If a different receiving antenna is desired connect that line to the REC ONLY jack.

### KEY

If CW operation is desired, connect a key to the KEY jack.

### RTTY

If RTTY operation is desired, connect the RTTY input to this jack. The TS-900 has a built-in frequency shift, factory adjusted for 850 Hz.

### POWER SUPPLY

Make sure the POWER switch on the front panel of the TS-900 is turned off, the stand-by switch is put in the REC position, and that the voltage switch on the back of the PS-900 is switched to the correct line voltage (120 or 240). Connect the POWER SUPPLY cord to the PS-900, the DS-900, or an appropriate external power supply.

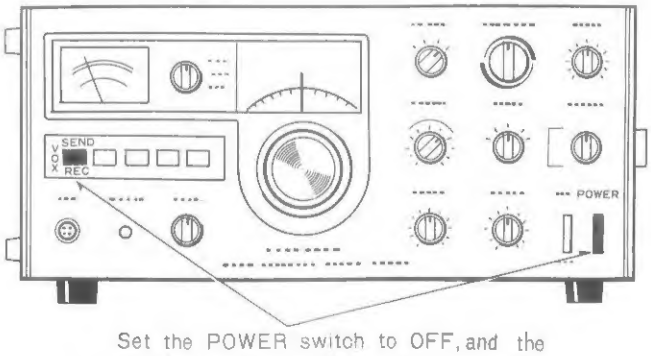
### SPEAKER

Connect the speaker cord to the SPEAKER jack on the back of the TS-900 and to the SPEAKER jack on the back of the PS-900 (or to an external 8 ohm speaker).

### MICROPHONE

Attach the microphone connector to a suitable microphone. Be sure that the PTT switch of the microphone is separate from the microphone circuit, as shown in Figure 3. Figure 4 shows how to install the microphone connector.

Finally connect the power supply to your power source.




Set the POWER switch to OFF, and the stand-by switch to REC before connecting the AC plug to an outlet.

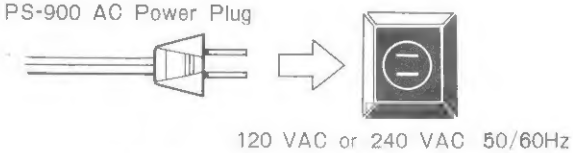



FIGURE 1. Initial Switch Settings

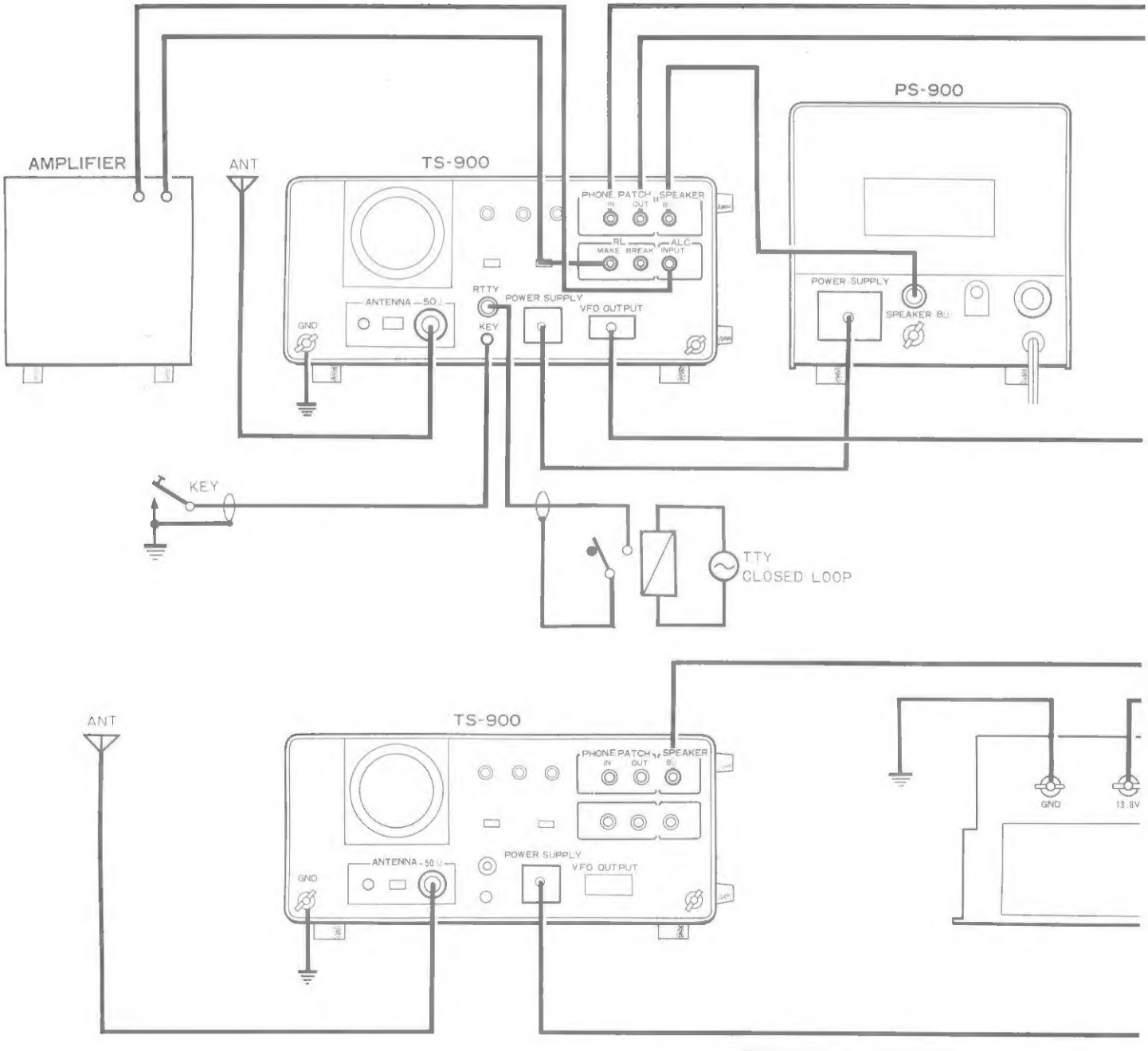
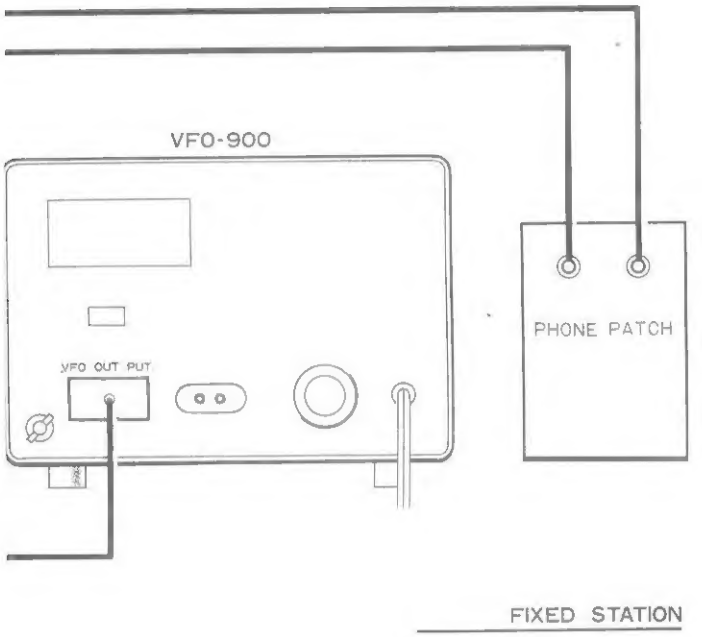
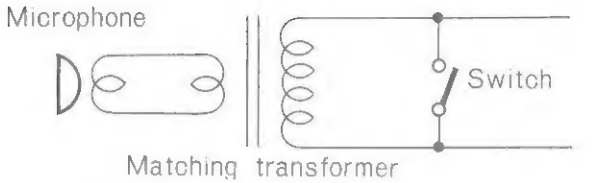
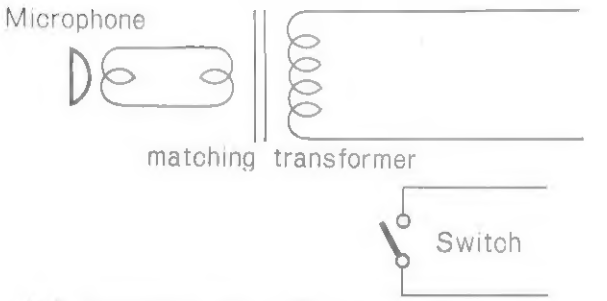



FIGURE 2. Wiring Diagram



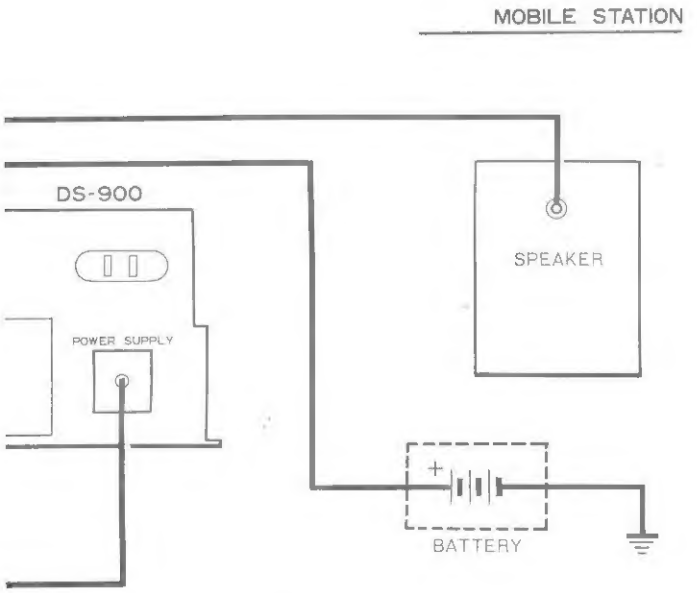




(a) Unsuitable for PTT operation.




(b) Suitable for PTT operation.

FIGURE 3. A Suitable PTT Microphone



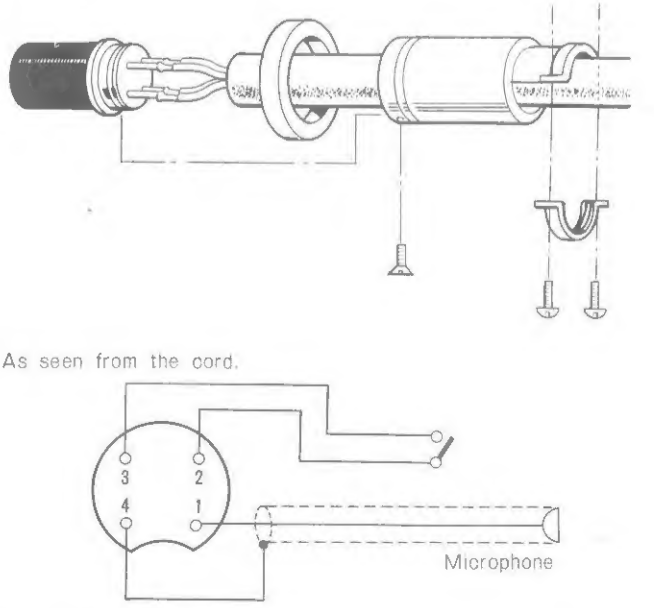




FIGURE 4. Microphone Connector Wiring

# SECTION 3. OPERATING CONTROLS

## 3.1 FRONT PANEL CONTROLS (See Figure 5)

**METER** (1 on Figure 5)

The meter monitors five different functions, depending on the position of the METER switch. In receive the meter is automatically an S-meter. The S-meter shows received signal strength on a scale of 0 to 40 db over S9.
In transmit the meter function depends on the position of the METER switch, as described below.

**METER SWITCH** (2 on Figure 5)

The position of the METER switch determines the function of the meter. The switch selects one of the following functions (see Table 5 for nominal meter readings):

ALC (Automatic Level Control) — In this position the meter monitors the ALC voltage of the internal ALC circuit (or the ALC voltage feedback from a linear amplifier operated in conjunction with the TS-900). For SSB operation the ALC reading for voice peaks should be within the indicated ALC segment of the meter.

IP (Plate Current) — In this position the meter monitors the plate current of the final tubes. The meter scale is calibrated from 0 to 600 ma.

RF (Output Power) — In this position the meter monitors relative output power of the transceiver. There is no meter scale for this position.

HV (High Voltage) — In this position the meter monitors the high voltage from the power supply. The meter scale is calibrated from 6 to 10, indicating 600 to 1000 volts.

**CAL (Calibrator) SWITCH** (3 on Figure 5)

The TS-900 contains a built-in crystal calibrator for calibrating the dial. The CAL switch selects either a 25 KHz or a 100 KHz calibrator, or turns the calibrator off.

**RF LAMP (AGC)** (4 on Figure 5)

This lamp is lighted when the RF AGC circuit is operating. The light shows when a strong signal is operating adjacent to the receiving frequency.

**RIT LAMP** (5 on Figure 5)

This lamp is illuminated when the RIT circuit is turned on, showing that the transmit and receive frequencies may be different. The RIT switch is explained below.

**T. MUTE LAMP** (6 on Figure 5)

This lamp is illuminated whenever the HEATER switch or the SG switch (on the rear panel) or both are turned off. When the light is on the TS-900 cannot transmit, even if the stand-by switch is turned to SEND.

**STAND-BY SWITCH** (7 on Figure 5)

This three position lever switch selects one of the following functions.

REC — The transceiver is receiving unless the PTT switch on the microphone is switched to transmit.

VOX — With the stand-by switch in this position the VOX circuit is turned on. In SSB operation transmit is controlled by voice and for CW the VOX circuit allows semi-break-in operation. The microphone PTT switch operates in this position also.

SEND — The TS-900 is locked into the transmit mode in this switch position.

**NB SWITCH** (8 on Figure 5)

The NB switch turns the built-in noise blanker circuit on and off. The noise blanker is designed to reduce pulsating ignition type noises. When the lever switch is flipped up, the circuit is turned on.

**RIT SWITCH** (9 on Figure 5)

This two position lever switch turns the RIT (Receiver Incremental Tuning) circuit on and off. With the switch flipped up the circuit is activated and the RIT lamp is lighted. The RIT/XTAL control can then adjust the receiver frequency independently of the transmit frequency.

**FIXED CHANNEL SELECTOR SWITCH** (10 on Figure 5)

This two position lever switch selects between two different fixed frequency channels which can be installed inside the transceiver. Fixed frequency operation is convenient for operation on often used frequencies. The fixed channel oscillator replaces the VFO when the RIT/XTAL control

is turned fully counterclockwise.

**AGC SWITCH** (11 on Figure 5)

The AGC switch controls the AGC (Automatic Gain Control) circuit giving the operator three choices:

OFF — It may be desirable to turn the AGC off when receiving a very weak signal.

FAST— The FAST AGC position is designed for use in CW and FSK operation.

SLOW— Use the SLOW AGC position for SSB.

**MIC CONNECTOR** (12 on Figure 5)

The microphone connector is four pronged, allowing use of a PTT microphone. Figure 4 shows how to wire the plug on the microphone cable.

**PHONES JACK** (13 on Figure 5)

The headphones jack allows use of an 8 ohm set of headphones with a ¼" phone plug attached. When the phones are plugged into the transceiver, the speaker is disconnected.

**PLATE/LOAD CONTROL** (14 on Figure 5)

The PLATE tuning control is the smaller diameter knob extending farthest from the panel. This control adjusts the plate tuning of the two 6LQ6 final tubes. The LOAD control, the silver ring, adjusts the loading of the pi-circuit of the transceiver.

**DRIVE CONTROL** (15 on Figure 5)

The DRIVE tuning control tunes the 6GK6 driver and the antenna mixer circuits.

**RIT/XTAL CONTROL** (16 on Figure 5)

This control serves two different purposes. When the knob is turned fully counterclockwise the fixed frequency oscillator is turned on. If crystals have been installed inside the transceiver, the fixed channel selector switch chooses between the two channels. Also, when the RIT lever switch is turned on, this control tunes the TS-900's receiver.
The RIT circuit allows the operator to tune the receive frequency more than ±2 KHz without changing the transmit frequency.

**BAND SWITCH** (17 on Figure 5)

This 6 position switch selects all the necessary circuits to tune the transceiver to the desired 500 KHz band, or WWV.

**B. SELECT SWITCH** (18 on Figure 5)

This auxiliary band switch selects the circuits to tune the

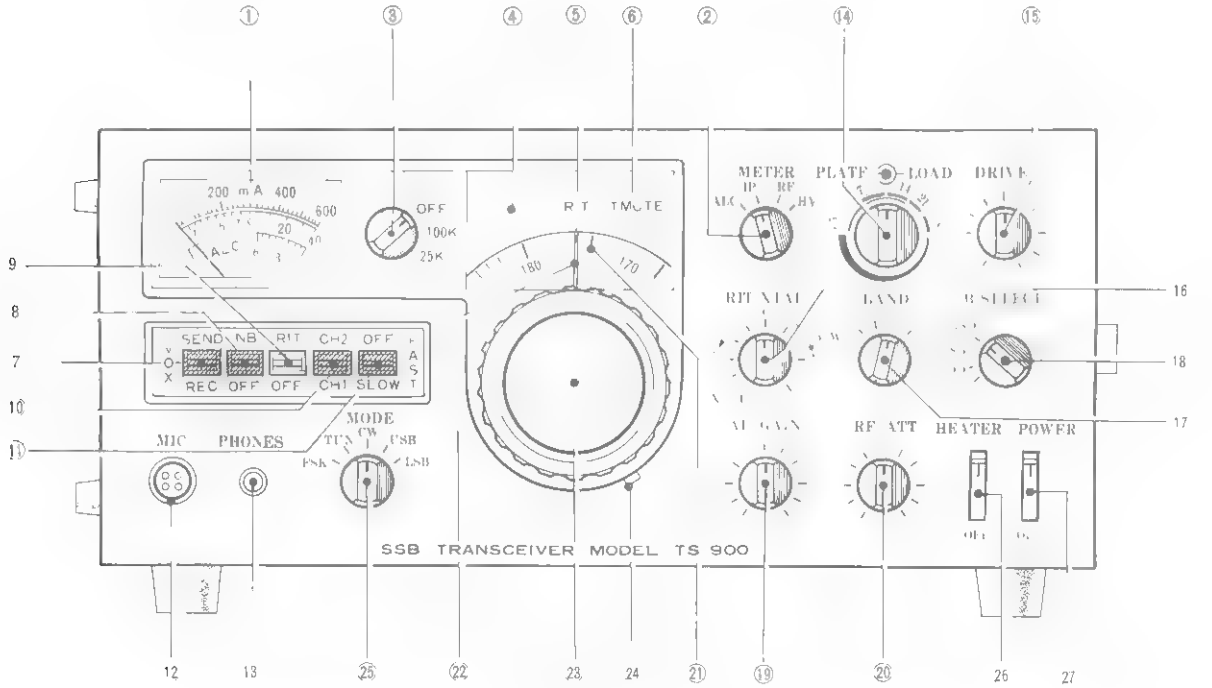



FIGURE 5. TS-900 Front Panel Controls.

TS-900 to the 500 KHz frequency range desired within the 10 meter band. Switch the BAND switch to the 28 MHz band and then set the B. SELECT switch to the correct range— 28.0 to 28.5, 28.5 to 29.0, 29.0 to 29.5, 29.5 to 30.0 MHz.

**AF GAIN CONTROL** (19 on Figure 5)

This control adjusts the gain of the receiving audio amplifier. The audio volume of the received signal increases as the control is turned clockwise.

**RF ATT CONTROL** (20 on Figure 5)

With the RF ATT control turned fully clockwise, the state of the receiver is normal and the attenuation is at zero. When the received signal is strong enough to light up the RF ATT lamp, the RF ATT control should be turned counterclockwise to obtain a proper receiving condition.
Turning the RF ATT control counterclockwise increases the attenuation in the ANT line, and a bias is applied to the AGC line simultaneously. Thus the S-meter deflects and the gain decreases in the RF and IF stages.
Turning the RF ATT control further counterclockwise causes the S-meter to deflect more and the gain to decrease further. With the control turned fully counterclockwise, the S-meter which has deflected to the full scale, is lowered to S9 or less. This state is convenient for receiving a marker signal since the attenuation is at maximum in the ANT line and the incoming signal is feeble.

**DIAL SCALE** (21 on Figure 5)

The dial scale provides a direct frequency readout, calibrated to 1 KHz. The sub-dial changes automatically to display the frequency every 10 KHz. The frequency displayed on the dial scale, when added to the base frequency of the chosen band, shows the exact operating frequency of the transceiver.

**DIAL POINTER** (22 on Figure 5)

This pointer serves as the reference for reading the operating frequency from the dial scale.

**MAIN TUNING KNOB** (23 on Figure 5)

This control turns the VFO and dial scale to select the frequency to be added to the band frequency to establish the transceiver's operating frequency.

**DIAL POINTER CALIBRATING LEVER**
(24 on Figure 5)

Use the crystal calibrator to send a marker signal at 100 KHz or 25 KHz intervals. Then zero-beat the marker signal and adjust the dial pointer, using the calibrating lever, until the pointer is directed towards the correct scale reading. The VFO has a calibrating capacitor on the bottom of the VFO section if the calibrating lever can not adjust the pointer sufficiently.

**MODE SWITCH** (25 on Figure 5)

This switch selects one of the following modes of operation.

FSK — Set the MODE switch to this position for RTTY operation to activate the built-in frequency shift circuit of the TS-900.

TUN — Turn the MODE switch to this position to generate a CW carrier for tuning the transceiver. In this position the screen voltage to the finals is reduced to prevent damage during tuning.

CW — This position is used for operating the TS-900 in the CW mode.

USB — This switch position selects the USB crystal filter on the XF board for operating on upper sideband. International amateur practice dictates the use of USB on the 14, 21, and 28 MHz bands.

LSB — This switch position selects the LSB crystal filter on the XF board for operating on lower sideband. International amateur practice dictates the use of LSB on the 3.5 and 7 MHz.

**HEATER SWITCH** (26 on Figure 5)

This switch turns the heater circuits of the three transmitting tubes on an off. The heaters would normally be turned to OFF to reduce power consumption in mobile or portable receiving. When the switch is turned OFF, the T. MUTE light is illuminated and the heaters are turned off.

**POWER SWITCH** (27 on Figure 5)

The POWER switch turns all power on and off in the TS-900 and its power supply.

## 3.2 SIDE PANEL CONTROLS (See Figure 6)

**MIC GAIN CONTROL** (1 on Figure 6)

The MIC GAIN control adjusts the gain of the microphone amplifier for SSB operation.

**VOX GAIN CONTROL** (2 on Figure 6)

This control adjusts the sensitivity of the VOX, by adjusting the gain of the VOX amplifier, for voice controlled operation.

## 3.3 REAR PANEL CONTROLS (See Figure 7)

**COOLING FAN** (1 on Figure 7)

This four vaned fan cools the RF amplifier section of the TS-900. The POWER switch turns the fan on and off.

**BIAS CONTROL** (2 on Figure 7)

The BIAS control adjusts the bias voltage of the two 6LQ6 amplifier tubes. Turning the control clockwise increases the idling plate current of the tubes. Section 4.7 describes adjustment of the bias current.

**RF VOLT CONTROL** (3 on Figure 7)

Use the RF VOLT control to adjust the sensitivity of the RF output function of the meter.

**ANTI VOX CONTROL** (4 on Figure 7)

This control adjusts the level of the anti VOX signal fed into the VOX circuit. Adjust the control to prevent feedback from the speaker from tripping the VOX circuit.

**SG SWITCH** (5 on Figure 7)

The SG slide switch controls the screen grid voltage on the 6LQ6 tubes. For tuning or neutralizing the TS-900 you can set the switch to the OFF position. When the switch is off the T. MUTE light is illuminated. Turn the switch back to the ON position for normal operation.

**VFO SWITCH** (6 on Figure 7)

The VFO slide switch selects between the internal (INT) VFO of the TS-900 and an external (RMT) VFO such as the VFO-900. For normal operation, without an external VFO, set the switch to INT. If the switch is set to RMT, and no remote VFO is attached, the internal VFO will not operate.

**PHONE PATCH IN JACK** (7 on Figure 7)

For operation with a phone patch connect a high impedance phone patch input to this jack.

**PHONE PATCH OUT JACK** (8 on Figure 7)

For operation with a phone patch connect the 600 ohm output from this jack to the phone patch.

**SPEAKER JACK** (9 on Figure 7)

The receiver audio output must be connected through this jack to the PS-900 or another external 8 ohm speaker.

**RL MAKE JACK** (10 on Figure 7)

This jack is connected to a relay in the TS-900 for controlling a linear amplifier or an external receiver. This relay contact is normally open during receive and shorted or closed to ground during transmit.

**RL BREAK JACK** (11 on Figure 7)

This jack is connected to a relay in the TS-900 for controlling a linear amplifier or an external receiver. This relay contact is normally closed to ground during receive and open during transmit.

**ALC INPUT JACK** (12 on Figure 7)

When the TS-900 is used with a linear amplifier which has provisions for ALC output, connect the output from the amplifier to this jack.

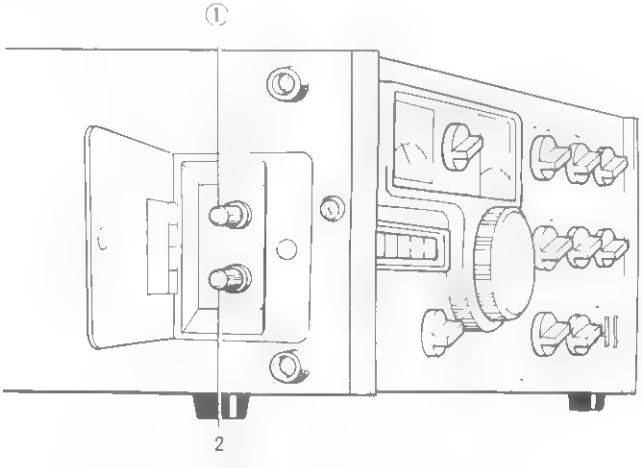



FIGURE 6. TS-900 Side Panel Controls

**GND (Ground) LUGS** (13 on Figure 7)

To prevent accidental shocks from the chassis, connect a good earth ground to one of these lugs.

**REC ONLY JACK** (14 on Figure 7)

Use this RCA phone jack to connect a receiving antenna when separate antennas are employed for transmit and receive. This jack connects an antenna directly into the receiver section of the TS-900.

**ANTENNA SWITCH** (15 on Figure 7)

Push this slide switch towards the coaxial connector marked 50 ohms when using a single antenna for receiving and transmitting. Set the switch towards the REC ONLY jack to use a separate receive and transmit antenna.

**ANTENNA 50 ohm CONNECTOR** (16 on Figure 7)

This SO-239 coax connector should be attached to a suitable antenna for transmitting and receiving or transmitting only. The antenna impedance should be 50 ohms unbalanced.

**RTTY JACK** (17 on Figure 7)

The RTTY jack should be connected to a teletype keyboard for FSK operation. The TS-900 has a built-in frequency shift circuit for FSK operation.

**KEY JACK** (18 on Figure 7)

Connect a key to this jack for CW operation.

**POWER SUPPLY CONNECTOR** (19 on Figure 7)

Use this 12 pin connector to attach the transceiver to the PS-900, the DS-900, or another suitable power supply.

**VFO OUTPUT CONNECTOR** (20 on Figure 7)

This 12 pin plug controls all of the input, output, and switching functions when the VFO-900 is used with the TS-900. With the VFO switch in the RMT position and the VFO-900 attached through this connector, all switching functions are controlled by the VFO-900.

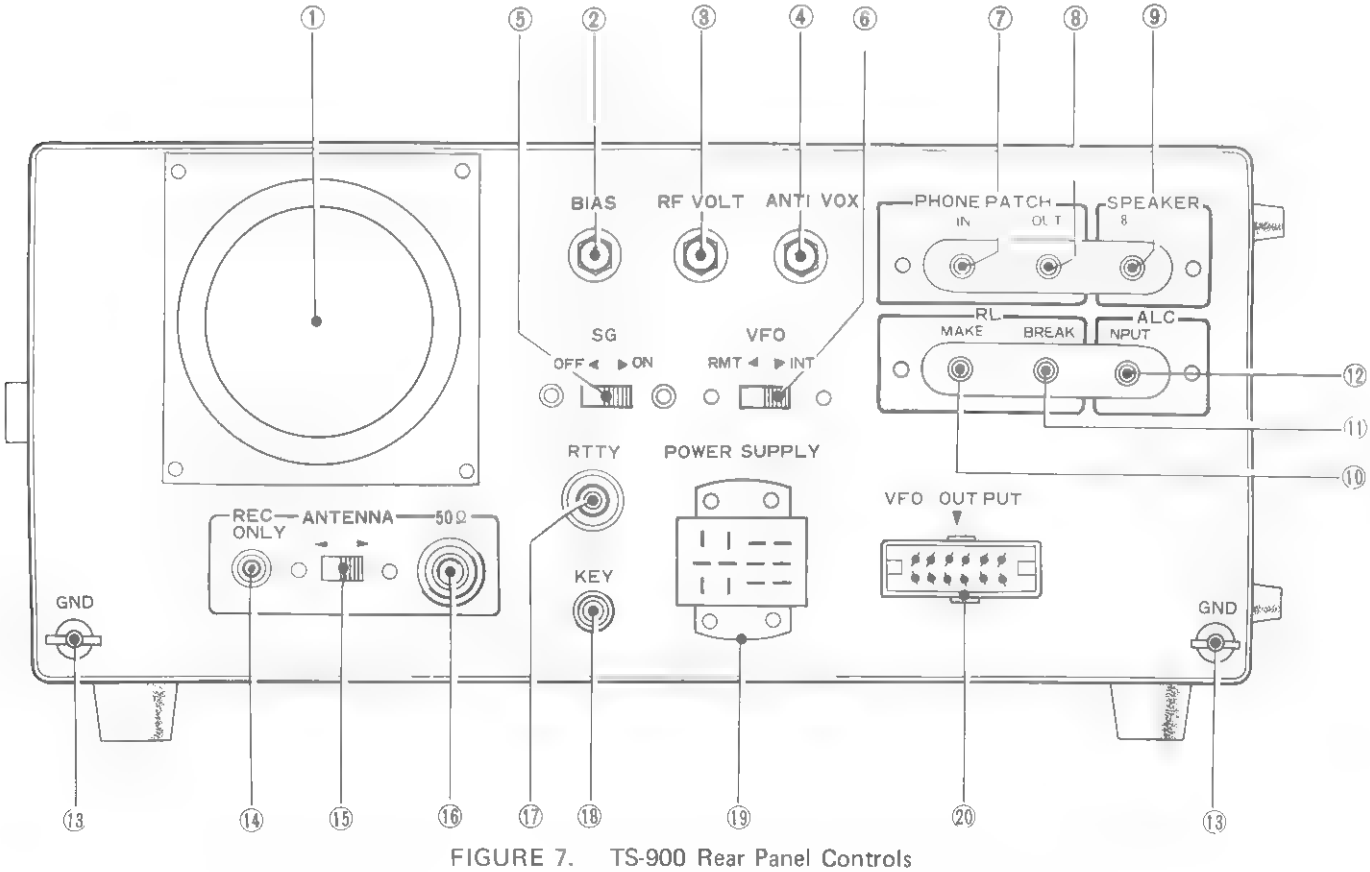



FIGURE 7. TS-900 Rear Panel Controls

# SECTION 4. OPERATING INSTRUCTIONS

## 4.1 PRELIMINARY PROCEDURE

Set the MIC GAIN control to off and the MODE switch to LSB, USB, or CW to prevent accidental transmit conditions before tuning. The TS-900 must be operated into a 50 ohm antenna or dummy load with an SWR less than 2:1. Random length wire antennas or light-bulb dummy loads cannot be used. Conventional half-wave dipoles and beam antennas should only be used at or near their resonant frequency. Exceeding an SWR of 2:1 can damage the components in the output stage of the transceiver.

Be sure to complete all of the required cabling, as described in Section 2.3.

## 4.2 RECEIVER TUNING

Refer to Table 2 below for the initial switch settings of the TS-900 for receiving, and then continue with the described procedure.

Push the POWER switch on. The meter, dial scale, and dial pointer will light, indicating that the transceiver is operating. The receiver section is fully solid-state allowing reception with the HEATER switch turned to OFF. The T. MUTE lamp should be lighted showing the HEATER switch is turned off.

**TABLE 2. Initial Switch Settings for Receiving**

| CONTROL LOCATION | CONTROL | POSITION |
|---|---|---|
| FRONT PANEL CONTROLS | POWER Switch | OFF |
| | HEATER Switch | OFF |
| | Stand-by Switch | REC |
| | NB Switch | OFF |
| | RIT Switch | OFF |
| | AGC Switch | SLOW |
| | MODE Switch | To the appropriate sideband |
| | PLATE/LOAD Control | Middle of the range for the band |
| | DRIVE Control | Centered |
| | RIT/XTAL Knob | Centered |
| | AF GAIN Control | Fully counter-clockwise |
| | RF ATT Control | Fully clockwise |
| | CAL Switch | OFF |
| REAR PANEL CONTROLS | ANTENNA Switch | Towards ANTENNA 50 ohms (unless a separate rec. ant. is used) |
| | VFO Switch | INT |
| | SG Switch | ON |

The remaining controls do not affect reception so they may be in any position.

Advance the AF GAIN control clockwise until some receiver noise is heard in the speaker. Turn the main tuning dial within the frequency range of the amateur band chosen until a signal is heard. Tune the signal for the clearest possible reception, and then adjust the DRIVE control for maximum deflection of the S-meter.

Strong signals engage the RF AGC circuit of the TS-900. When this happens, the RF AGC lamp on the front panel will light. If the AGC is operating turn the RF ATT control counter-clockwise to attenuate the signal until the RF AGC light goes out.

## 4.3 CALIBRATION

The TS-900 has a built-in crystal calibrator which can generate marker signals at 100 or 25 KHz intervals to accurately calibrate the dial pointer.

**SSB OPERATION** (See Figure 8)

Set the MODE switch to USB or LSB and turn the CAL switch to 25K or 100K to turn on the crystal calibrator.

Turn the main tuning knob to the nearest 100 KHz or 25 KHz (if the CAL switch is at 25K) and decrease the AF GAIN control as necessary for a comfortable listening level. Tune the VFO until the calibrator signal is zero beat. When the calibrate signal is zero beat in the receiver, set the dial pointer to the 100 KHz or 25 KHz point on the dial scale with the dial pointer calibrating lever. If the dial pointer cannot be moved far enough to calibrate the transceiver see Section 6.9 for internal calibration. For SSB operation the pointer now indicates the carrier frequency for transmission and reception.

**CW OPERATION** (See Figure 8)

When operating the TS-900 on CW, calibrate the dial pointer as described in the preceding paragraph. For reception of a CW signal the dial pointer indicates the frequency of the BFO, and therefore the transmitting frequency is approximately 850 Hz higher than the dial reading. When the accessory CW filter is used, the dial pointer indicates the operating frequency and the BFO frequency is approximately 850 Hz higher than the dial reading. The TUN position calibration is the same as CW calibration.

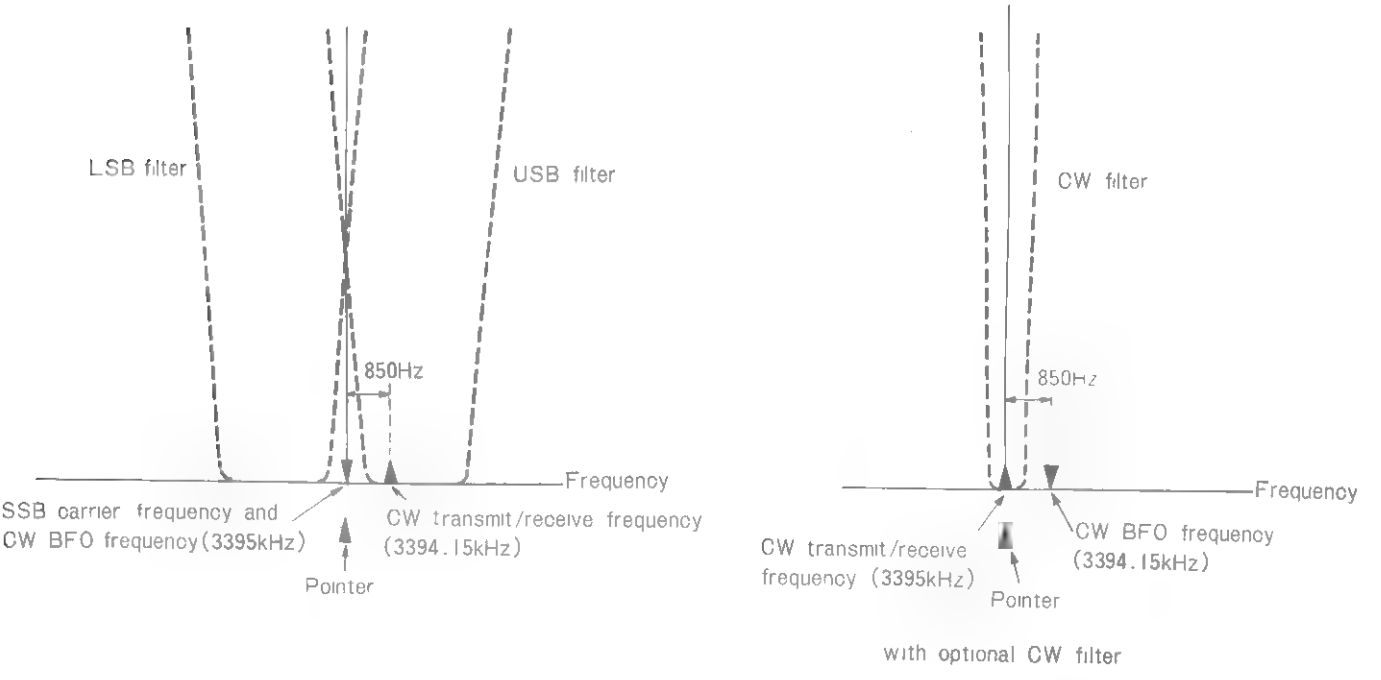



FIGURE 8. Dial Pointer Calibration for SSB and CW Operation

**FSK OPERATION** (See Figure 9)

When calibrated as described under SSB operation, in the FSK mode the dial pointer shows a frequency 850 Hz lower than the supposed carrier frequency. The transmit frequencies are 2125 Hz and 2975 Hz lower than the suppressed carrier frequency (or 1275 and 2125 Hz lower than the frequency indicated by the dial pointer).

## 4.4 NOISE BLANKER

The TS-900 has a sophisticated built-in noise blanker designed to reduce ignition type impulse noises. The noise blanker is particularly important for mobile operation.
When necessary, activate the noise blanker circuit by flipping the NB switch up.

## 4.5 AGC (Automatic Gain Control)

Set the AGC switch to the position appropriate for the received signal. Generally for SSB reception set the AGC switch to SLOW, for CW reception set the AGC switch to FAST, and for reception of a very weak signal the switch may be set to off.

The RF AGC function is a valuable and unique feature of the TS-900 which prevents the front-end overload problem associated with many transceivers. When the RF AGC is activated by an adjacent channel signal, the S-meter reading of the in-channel signal will be reduced.

## 4.6 RIT (Receiver Incremental Tuning)

With the RIT switch turned off the TS-900 receives and transmits at the same frequency. At times the received signal may drift off frequency and become less intelligible. When this happens, flip the RIT switch up to activate the RIT circuit and return the received signal to an intelligible state using the RIT/XTAL control. The RIT circuit has no effect on the transmit frequency. When the RIT switch is turned on the RIT light is illuminated. Be careful to turn the RIT to the OFF position when returning to normal transceive operation to prevent unintentionally transmitting and receiving on different frequencies.

VR2 on the CONT board adjusts the zero point of the RIT control (see Section 6.12).

**TABLE 3. Initial Switch Settings for Transmission**

| LOCATION | CONTROL | POSITION |
|---|---|---|
| FRONT PANEL CONTROLS | POWER Switch | ON |
| | HEATER Switch | ON |
| | Stand-by Switch | REC |
| | MODE Switch | USB or LSB depending on band |
| | METER Switch | IP |
| | PLATE/LOAD Control | Middle of the range for the band |
| | DRIVE Control | Centered |
| | RIT/XTAL Control | Centered |
| REAR PANEL CONTROLS | ANTENNA Switch | Towards ANTENNA 50 ohms (unless a separate receive antenna is used, then towards REC ONLY) |
| | SG Switch | ON |
| | VFO Switch | INT |

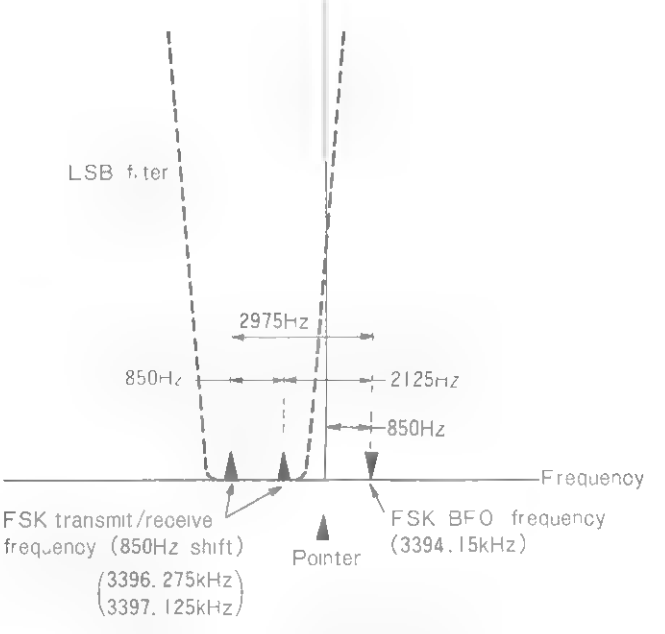



FIGURE 9. Dial Pointer Calibration for FSK Operation

## 4.7 TRANSMITTER TUNING

Connect the TS-900 to a 50 ohm dummy load or a 50 ohm antenna with an SWR of less than 2:1 before making any transmitter adjustments. The life of the final tubes is directly related to the SWR of the antenna and to the length of tuning periods.

Refer to Table 3 for the initial switch settings of the TS-900 for transmitting. Tune the main tuning knob to the desired operating frequency.

### PLATE IDLING CURRENT (See Figure 10)

Turn the main tuning knob to the desired operating frequency within the amateur band selected. Flip the stand-by switch to SEND and check that the plate current (IP) is 60 ma. The IP scale of the meter is marked with a ▼ at 60 ma. If the plate current is not correct, adjust the rear panel BIAS control for a correct 60 ma of idling current and return the stand-by switch to REC.

**CAUTION:**

*If the plate current is very much higher than 60 ma do not leave the stand-by switch for more than a few seconds. Excessive plate current shortens the life of the 6LQ6 final tubes.*

### PLATE TUNING (See Figure 11)

After adjusting the idling current, shift the MODE switch to TUN and the stand-by switch to SEND. Quickly adjust the PLATE control to dip the plate current (a minimum meter reading).

**NOTE:**

*The TUNE position permits tuning of the final tank circuit at reduced power without danger to the tubes. With the MODE switch in the TUN position, the screen voltage of the finals is reduced to approximately 50 volts and the keying circuit is shorted.*
*In the TUN mode the TS-900 operates at the same frequency at which it would operate in the CW mode.*

If the IP reading is too low to dip, adjust the DRIVE control for a higher reading. The dip should occur with the PLATE control within the range for the selected band (as shown on the front panel).

### DRIVE TUNING (See Figure 11)

Shift the METER switch to ALC and peak the ALC reading (maximum meter deflection) with the DRIVE control. The stand-by switch is still in the SEND position.

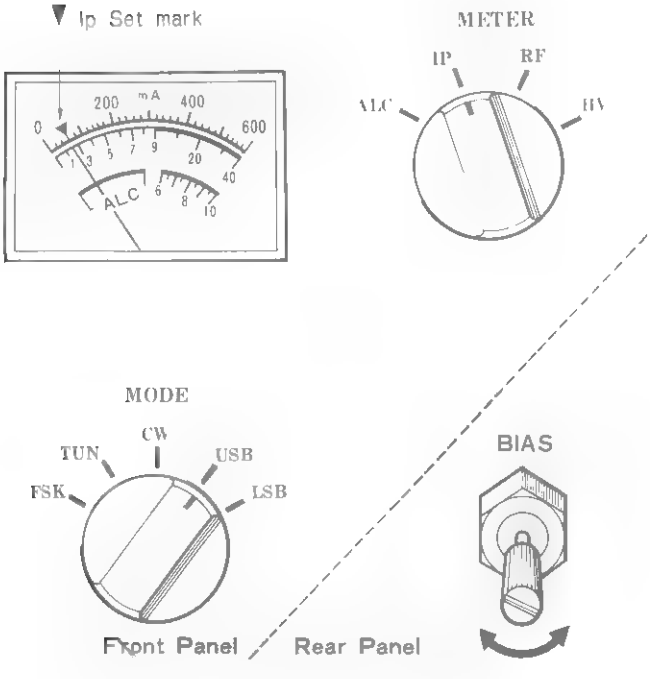



FIGURE 10. Adjustment of the Plate Idling Current

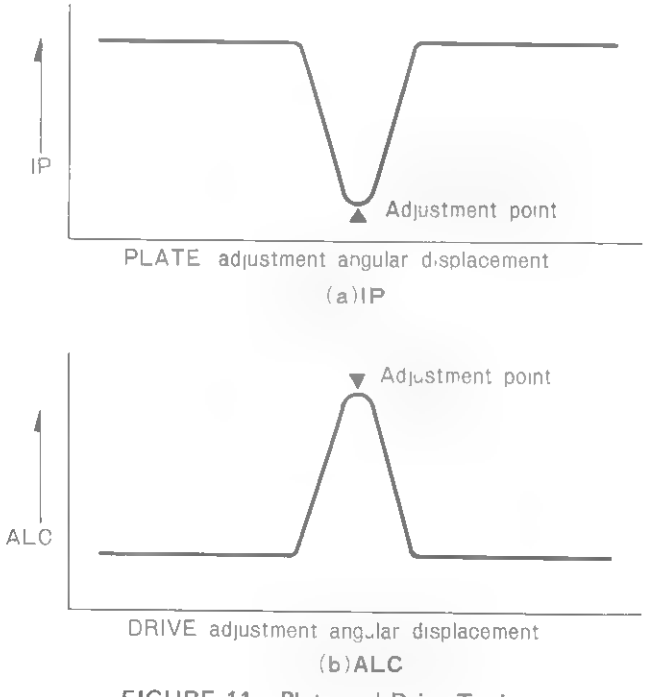



FIGURE 11. Plate and Drive Tuning

### PLATE AND LOAD TUNING

**CAUTION:**

*When the MODE switch is in the CW position the final tubes draw full plate current in transmit. Final tube life is directly related to the length of tune-up periods. Do not transmit with the tubes out of resonance for more than 10 seconds at a time.*

Turn the MODE switch to CW, turn the METER switch to RF, and keep the stand-by switch in the SEND position. Quickly adjust the PLATE control and then the LOAD control alternately to peak (maximum meter deflection) the power output. The peak should occur about 400 ma on the IP scale (the METER switch is still in the RF position. If necessary, adjust the RF VOLT control on the rear panel to bring the output reading to 400 ma.

**TABLE 4. Summary of Transmitter Tuning Procedures**

| MODE Switch | METER Switch | Stand-by Switch | Procedure |
|---|---|---|---|
| USB or LSB | IP | SEND | Adjust BIAS control for 60 ma. |
| TUN | IP | SEND | Dip plate current with PLATE control. |
| TUN | ALC | SEND | Peak the ALC reading with the DRIVE control. |
| CW | RF | SEND | Peak RF output by alternately adjusting the PLATE AND LOAD controls. |

## 4.8 SSB OPERATION

### PTT OPERATION

Tune the TS-900 as described in Sections 4.1 to 4.7. Set the MODE switch to USB or LSB and connect a microphone to the MIC connector.

**NOTE**

*International amateur practice dictates using USB or LSB on the following bands.*

| | |
|---|---|
| 3.5 MHz Band | LSB |
| 7.0 MHz Band | LSB |
| 14.0 MHz Band | USB |
| 21.0 MHz Band | USB |
| 28.0 MHz Band | USB |

Key the transmitter and speak into the microphone with the tone of voice used in normal operation. Adjust the MIC

GAIN control, on the left side of the TS-900, until voice peaks are just within the top limit of the ALC range printed on the meter scale. The METER Switch is in the ALC position. If the transmitter section is driven beyond this range, the transmitted signal will be distorted.

### VOX OPERATION

Adjust the transceiver as described in the previous paragraph. Flip the stand-by switch to VOX and close-talk into the microphone, increasing the VOX GAIN control (on the left side of the TS-900) until the VOX relay just operates. For VOX operation it is desireable to close-talk the microphone to prevent background noises from tripping the TS-900 into transmission.

Check that the ALC reading for voice peaks is still within the ALC range on the meter. If necessary, adjust the MIC GAIN for a proper ALC reading.

If the VOX circuit is activated by speaker noise, adjust the ANTI VOX control on the back panel. Increase the control as necessary for proper VOX operation.

Do not use more VOX GAIN or more ANTI VOX gain than necessary to control VOX operation. If the VOX circuit transfers between words, or holds too long, adjust the release time constant by turning VR1 on the VOX-MKR board, X54-1020-10. See Section 5.11.

## 4.9 CW OPERATION

Tune and load the TS-900 as described in Sections 4.1 through 4.7. Connect a key to the back panel Key jack, set the MODE switch to CW, and set the stand-by switch to SEND for transmitting.

NOTE

*See Section 4.3 for information on dial calibration for CW operation.*

CW transmissions are automatically monitored through the speaker of the transceiver. The audio gain of the sidetone can be adjusted with VR1 on the AF board, X49-1020-10 (See Figure 26).

For semi-break-in operation, set the stand-by switch to VOX. Hold the key down and increase the VOX GAIN control, on the left side of the transceiver, until the VOX relay just operates. If it is desired to change the release time constant of the VOX circuit, adjust VR1 on the VOX-MKR board.

The plate current for CW operation should be about 260 ma. Use VR1 on the CONT board to adjust the carrier level for CW operation (see Section 5.10).

## 4.10 RTTY OPERATION

CAUTION

*The TS-900 uses a hot switching system. Be careful not to short the RTTY jack to the chassis or any other ground.*

Tune and load the TS-900 as described in Sections 4.1 through 4.7. For RTTY operation in FSK, set the MODE switch to FSK and connect the keyboard input to the rear panel RTTY jack. Connect the PHONE PATCH OUT jack (or the SPEAKER jack) to the input of the RTTY terminal.

NOTE

*See Section 4.3 for information on dial pointer calibration for FSK operation.*

The TS-900 has a built-in 1275 and 2125 Hz, 2 tone keyer, therefore an external keyer is not necessary. The 850 Hz frequency shift is standard for amateur FSK operation.

Flip the stand-by switch to SEND to transmit (or set the stand-by switch to VOX), key the teletypewriter, and adjust the VOX GAIN control until the VOX relay just operates.

Adjust the RF ATT control fully clockwise. Adjust the AF GAIN control for the amount of receive power required by the converter.

**TABLE 5. Meter Switch Positions for Different Modes**

| MODE | METER Switch | Approx. Readings |
|---|---|---|
| FSK | * IP or | 210 ma |
| | RF or | 250 |
| | HV | 800v |
| TUN | * ALC or | Peaked |
| | * IP or | 120 ma |
| | * RF or | 150 |
| | HV | 800 v |
| CW | ALC or | Top of the ALC Range |
| | * IP or | 300 ma |
| | RF or | 400 |
| | HV | 750 v |

| | | |
|---|---|---|
| USB or LSB | * ALC or | Within the ALC range on voice peaks |
| | IP or | 60 to 350 ma |
| | RF or | 0 to 400 |
| | HV | 800 v |

* Recommended monitoring position during operation.

## 4.11 OPERATION WITH A LINEAR AMPLIFIER

Tune and load the TS-900 as described in Sections 4.1 through 4.7 and adjust it for the selected mode. Connect the appropriate transceiver relay control jack to the relay control jack of the amplifier. See the instruction manual of the amplifier to determine whether the linear requires the RL MAKE (normally open in receive) or the RL BREAK (normally closed in receive) jack. Connect the ALC output jack of the amplifier to the ALC INPUT jack of the TS-900.

The ALC feedback of the amplifier should prevent the TS-900 from overdriving the linear for SSB operation. However, for tuning be careful not to overdrive the amplifier. If necessary, tune the amplifier with the TS-900 in the TUN mode to reduce power. Also, be careful not to overdrive the amplifier for CW operation.

## 4.12 OPERATION WITH AN EXTERNAL RECEIVER

To operate the TS-900 with an external receiver, connect the mute connection of the receiver (see the instruction manual of the receiver) to the appropriate relay contact (RL MAKE or RL BREAK) on the back panel of the transceiver. The Kenwood R-599 requires the RL MAKE relay contact, however many other amateur receivers use a break contact.

If the TS-900 is used with both an external receiver and a linear amplifier which require the same type of relay contact, an external relay may be required. In this case choose a relay that can be controlled by the opposite relay jack of the transceiver.

You can use the TS-900 with the R-599, and use the VFO in the R-599 for cross channel operation. To do this make the connections described below.

| TS-900 VFO OUTPUT Plug | | R-599 REMOTE Plug |
|---|---|---|
| pin 1 | coax to | pin 1 |
| pin 7 | shield to | pin 9 |
| pin 6 | 9 volts to | pin 11 |
| pin 11 | mute to | pin 7 |
| jumper pin 3 to pin 4 | | Jumper pin 4 to pin 5 |

In this configuration, the relay contact described above is not a necessary connection since the mute function is controlled through the interconnecting cables. When the equipment is connected in this manner, the VFO SELECT switch of the R-599 controls the functions of each VFO.

| R-599 VFO SELECT Switch | Transmitting VFO | Receiving VFO |
|---|---|---|
| NORMAL | TS-900 | R 599 |
| RX | R-599 | R-599 |
| TX | TS 900 | TS 900 |
| REVERSE | R 599 | TS 900 |

To use the cross operating feature you must switch the TS-900 VFO switch to the RMT position. To receive on two different frequencies at the same time, you must disconnect the R-599 from the TS-900 (or switch the TS-900's VFO switch to the INT position).

## 4.13 CHANGING THE BAND COVERAGE

The TS-900 is supplied for amateur band use. However, in cases where the owner is willing to sacrifice one or more of the standard frequency ranges, he can substitute an adjacent special range by changing the appropriate high frequency crystal.

The transition is easiest on the 10 meter band because there are four frequency ranges. For special frequencies above or below the amateur bands, such as MARS frequencies or others, you can achieve coverage by replacing the appropriate HF crystal, not to be confused with fixed frequency operation.

An exception to this rule is frequencies above 30 or below 3.5 MHz or near the IF frequency. These ranges are outside of the basic tuning capabilities of the transmitter. You should remember however that the farther away from the amateur bands the more out of resonance you become. In receive you lose sensitivity and in transmit you lose power output. Also on transmit if you are too far from the standard band you will begin to burn out components. Retune the transmitter and receiver coils for the new frequency as described in Section 6, substituting the required operating frequency in Table 5.

The band crystals for the TS-900 are as follows:

X1 for 15.0 MHz is 23.895 MHz
X2 for 3.5 MHz is 12.395 MHz
X3 for 7.0 MHz is 15.895 MHz
X4 for 14.0 MHz is 22.895 MHz
X5 for 21.0 MHz is 29.895 MHz
X6 for 28.0 MHz is 36.895 MHz
X7 for 28.5 MHz is 37.395 MHz
X8 for 29.0 MHz is 37.895 MHz
X9 for 29.5 MHz is 38.395 MHz

The band coverage will change exactly the same amount as the band crystal is changed. For example if you replace X3 by 15.395 crystal the 40 meter band position will cover 6.5 to 7.0 MHz (500 KHz below).
Or if you replace X6 by a 35.895 crystal your coverage on the lower 10 meter band would be from 27.0 to 27.5 instead of 28.0 to 28.5. You change the band crystal exactly the amount you wish to change the band coverage and in the same direction. Be sure and choose the amateur band closest to the operating frequency you wish.

Crystal Specifications: Type HC-18.

## 4.14 FIXED FREQUENCY OPERATION

The TS-900 has a built-in crystal controlled oscillator for fixed frequency operation. This feature is most useful for commonly used frequencies, nets, novice operation, or any situation where crystal controlled operation is required. To use the fixed frequency oscillator, turn the RIT/XTAL control fully counter-clockwise to the XTAL position. Select one of the two available channels with the fixed channel selector switch and tune and load the TS-900 as described in Sections 4.1 through 4.7. Simply operate the transceiver as described in Sections 4.8 through 4.11.

Section 5.12 describes installation and netting of fixed channel crystals. The crystal frequency is determined by the following formula.

Crystal Frequency (in MHz) = 5.5 MHz + X (in MHz) – Desired Operating Frequency (in MHz)

X = 3.5 for the 80 meter band
X = 7.0 for the 40 meter band
X = 14.0 for the 20 meter band
X = 21.0 for the 15 meter band
X = 28.0 for the 10 meter band or
X = 28.5 for the 10 meter band or
X = 29.0 for the 10 meter band or
X = 29.5 for the 10 meter band

Crystal Specifications: HC-25/U holder, 5.0 to 5.5 MHz oscillation frequency, and see Figure 33 for type of oscillation circuit.

Example: Desired Operating Frequency = 7.255 MHz
Crystal Frequency = 5.5 MHz + 7.0 MHz – 7.255 MHz
= 5.245 MHz

This same crystal will operate on each band.
Operating Frequency = 5.5 MHz + X (in MHz) – Crystal Frequency (in MHz)

Example: Crystal Frequency = 5.245 MHz
On the 14 MHz band the crystal will oscillate at
Operating Frequency = 5.5 MHz + 14.0 MHz – 5.245 MHz
= 14.255 MHz

## 4.15 OPERATION WITH A PHONE PATCH

The TS-900 has rear panel jacks to facilitate using the TS-900 with a phone patch. The PHONE PATCH OUT jack has an impedance of 600 ohms and the PHONE PATCH IN jack requires a high impedance input. See the instruction sheet of the phone patch for cabling instructions.

## 4.16 SSTV OPERATION

The TS-900 will adapt very well to slow scan television operation. The only cabling required are connections between the MIC connector of the TS-900 (or the PHONE PATCH IN jack) and the output of the television console, and between the SPEAKER jack of the TS-900 and the input of the television console.

Be careful to keep the input power of the transceiver down to a safe level with the MIC GAIN control. If you exceed the plate power dissipation capability of the tubes, they will be damaged.

## 4.17 NOVICE OPERATION

The Kenwood TS-900 offers the unique opportunity to the beginning amateur of buying a top quality ham rig which adapts to novice operation at very little cost. So the initial equipment investment is good for what ever level of license to which the operator advances.

For the novice to operate the Kenwood within the legal power limitation, all he has to do is remove one of the final tubes from the final RF section and replace it with a low cost module available from your dealer. Alternately, adjust the carrier level control to keep the plate input power below 75 watts (approximately 90 ma). Adjusting the carrier level yields much less power output because it reduces the efficiency of the tubes. Then to crystal control the transceiver just use the fixed channel feature of the TS-900. When the transceiver is used with the external VFO or with the R-599 there are five additional channels available for fixed frequency operation.

# SECTION 5. CIRCUIT DESCRIPTION

## 5.1 GENERAL DESCRIPTION

Figure 48 shows the block diagram of the TS-900. The transceiver is totally solid state, except for the two final tubes and the driver, utilizing 3 IC's, 73 transistors, and 70 diodes.

Modular construction techniques place all circuitry, except the final RF section, on plug-in circuit boards. These plug-in modules greatly simplify trouble shooting and repair procedures.

Receiver circuitry is designed in a crystal controlled double superheterodyne configuration. The transistorized transmitter section employs a dual conversion configuration using a filter type SSB generator.

Dual gate MOS FET's are used throughout the transmit/receive amplifier, except for the three power tubes and the AF amplifier. The use of these transistors allows excellent two-signal performance as well as excellent AGC (and ALC) characteristics.

### TRANSMITTER SECTION

The current generated by audio at the microphone is amplified by the microphone amplifier (located in the generator unit). The output from the microphone amplifier is injected, along with a 3.395 MHz carrier, into the four diodes which form the balanced modulator. The DSB output produced by the balanced modulator is fed to the first IF amplifier and then through either the USB or the LSB filter (in the XF unit) resulting in an SSB signal.

The 3.395 MHz SSB signal is mixed with the output of the VFO (5.5 to 5.0 MHz) by the first transmit mixer creating the second transmit IF signal (8.895 to 8.395 MHz). This signal is mixed with the output of the heterodyne crystal controlled oscillator, by the second transmit mixer, to produce the final transmitted SSB frequency.

This SSB signal is amplified by the 6GK6 driver tube to drive the two 6LQ6 amplifier tubes in the final stage. They operate in class AB 1. The output signal is transmitted through a pi-network to the antenna. The impedance of the pi-network is 50 ohms.

### RECEIVER SECTION

The incoming signal from the antenna is fed through the antenna coil to the RF unit, where it is one-stage amplified. The amplified signal is passed to the first receiver mixer for conversion to the first IF signal (8.895 to 8.395). The first IF signal is mixed with the VFO output by the second receive mixer to generate the second IF signal.

The RF AGC voltage is extracted at the output of the second mixer. The signal passes to the NB unit where it is amplified and passed through the blanking gate. The blanking gate is turned on, or open, when the noise blanker switch is turned to the OFF position. When the noise blanker switch is turned on, the gate opens and closes (as controlled by the noise components separated from the signal by the input filter of the noise blanker-circuit).

The signal then feeds through one of the crystal filters, selected by the MODE switch, to be amplified by the two-stage amplifier in the IF unit and detected by the detector in the generator unit. Here the RF signal is transformed to AF.

The AF signal, filtered by the low-pass filter, is amplified by the complimentary amplifier. The AF output impedance is 8 or 600 ohms.

## 5.2 VFO BOARD (X40-1020-10) (See Figure 12)

The inherent frequency stability and readout accuracy of the TS-900 result from the care and quality of the design and components of the VFO (Variable Frequency Oscillator).

To enhance the reliability of the VFO, the TS-900 uses an FET (Q1) for oscillation and a buffer stage (Q2, Q3 and Q4) for buffer amplification. This design insures high frequency stability under load fluctuations. Also included in the circuit are protections against frequency fluctuations from temperature changes and mechanical variations.

The oscillator frequency ranges from 5.0 to 5.5 MHz. The angular displacement of the variable capacitor is reduced from the displacement of the main tuning knob through a series of gears. One revolution of the main tuning knob tunes through 25 KHz of the band.

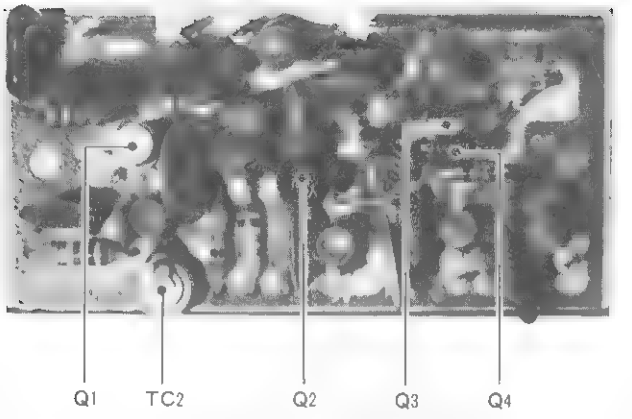



FIGURE 12. VFO Board

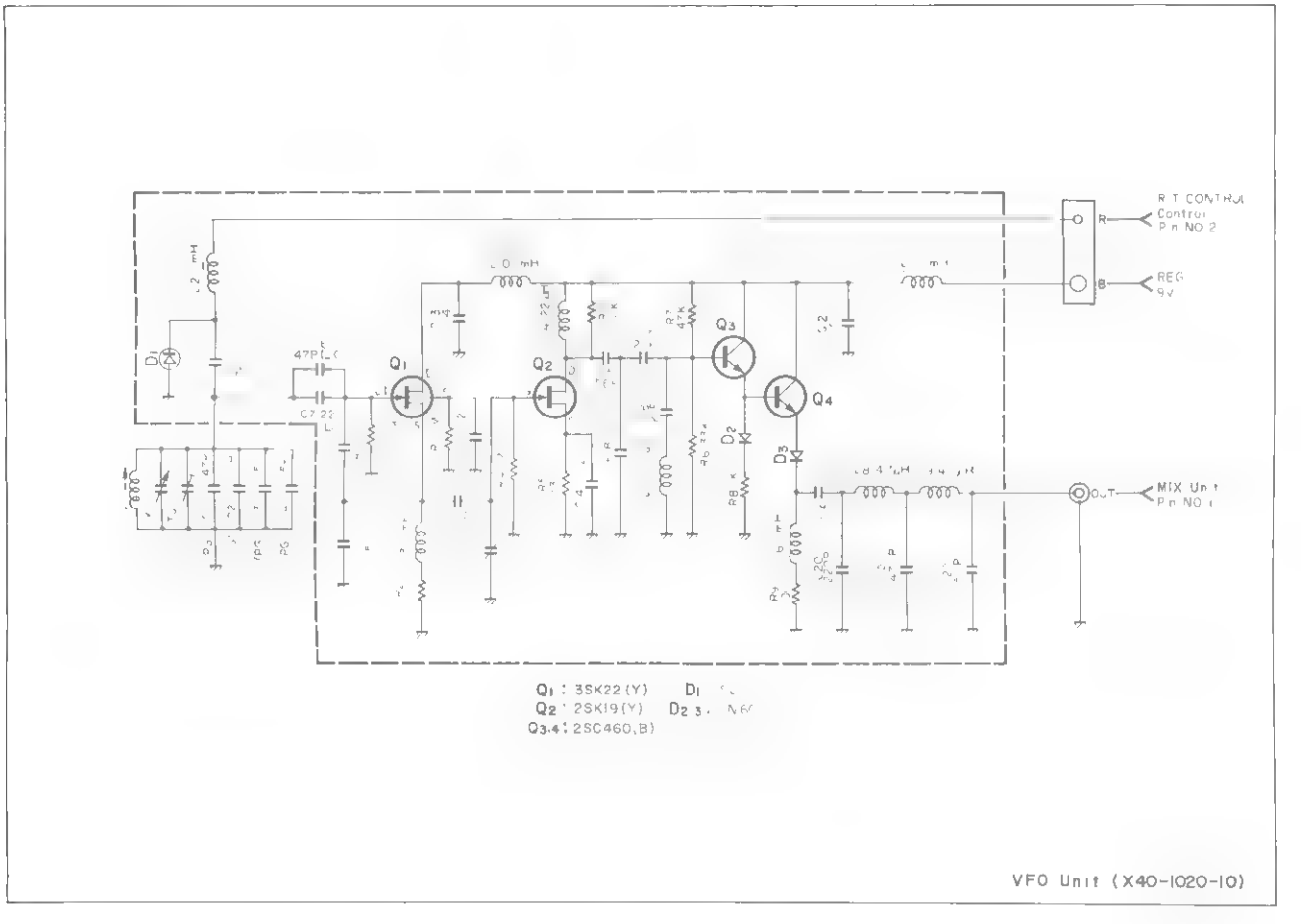



FIGURE 13. VFO Schematic

## 5.3 CAR-AVR (Carrier/Automatic Voltage Regulator) BOARD (X50-1030-10) (See Figure 14)

### CARRIER OSCILLATOR

This crystal-controlled oscillator produces a carrier signal during transmission and acts as the BFO for balanced product detection during reception. The circuit uses a diode switch for frequency switching.

### AVR (See figure 14)

The automatic voltage regulator circuit detects a reference voltage across the IC module to control the output transistor, Q6, to deliver stable 9 volt power to the load. The IC and output transistor are protected from a shorted output by a circuit consisting of Q3, Q4 and Q5.

### SWITCHING CIRCUIT

The board also holds a TDB/RDB switch to transfer signals between the transmit and receive circuits.

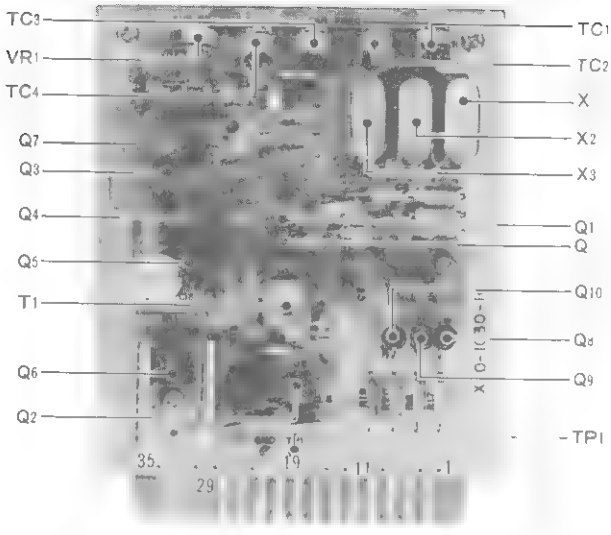



FIGURE 14. CAR-AVR Board

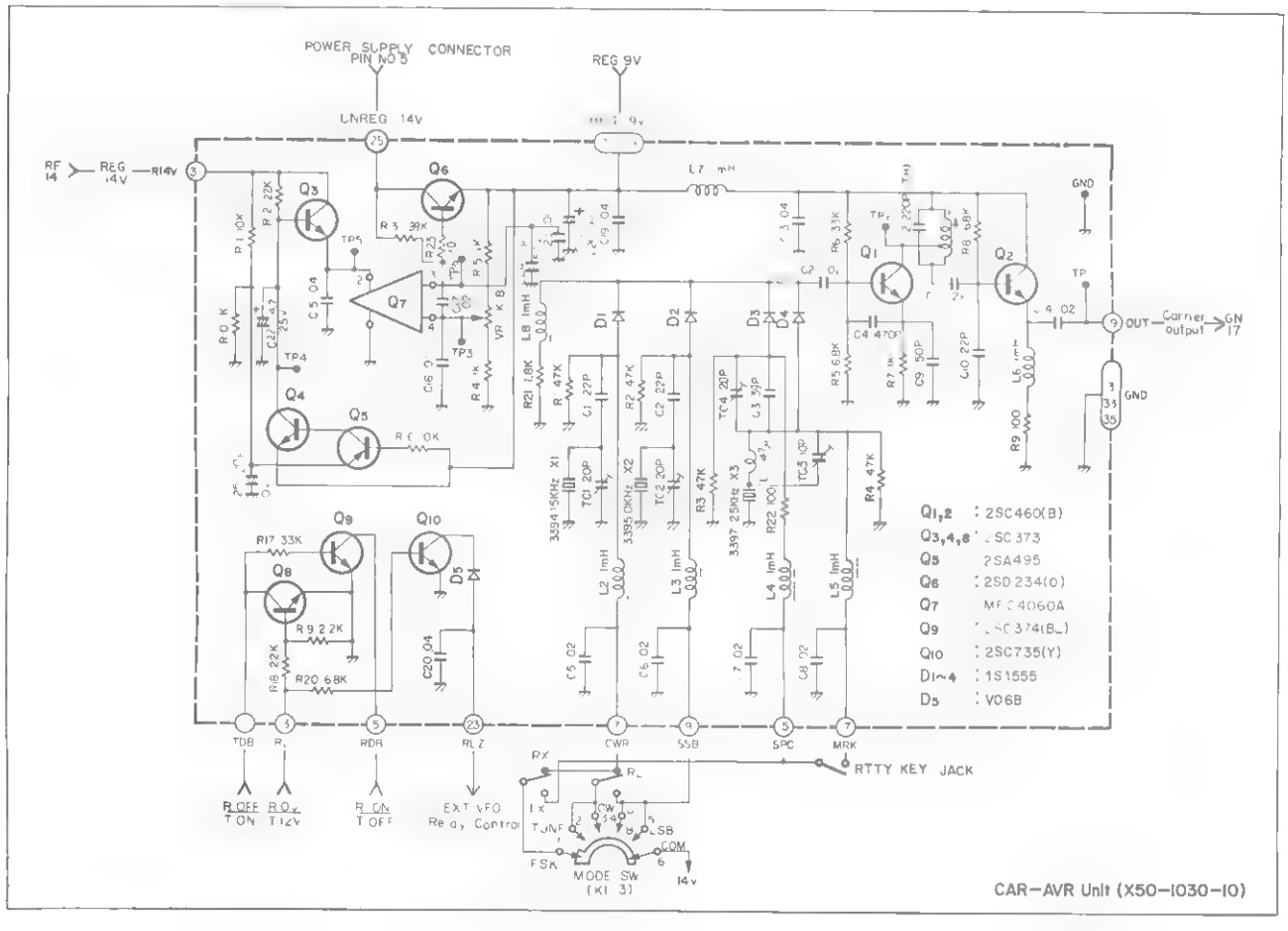



FIGURE 15. CAR-AVR Schematic

## 5.4 GEN (Generator) BOARD (X52-1010-10) (See Figure 16)

During transmission, the generator circuit produces a DSB signal. The circuit consists of a high input impedance microphone amplifier and a four-diode balanced modulator.

The DSB signal is fed through the IF amplifier (Q4), where its level is automatically controlled by the ALC, and then to the XF board. The GEN board also holds the receiver's balanced product detector.

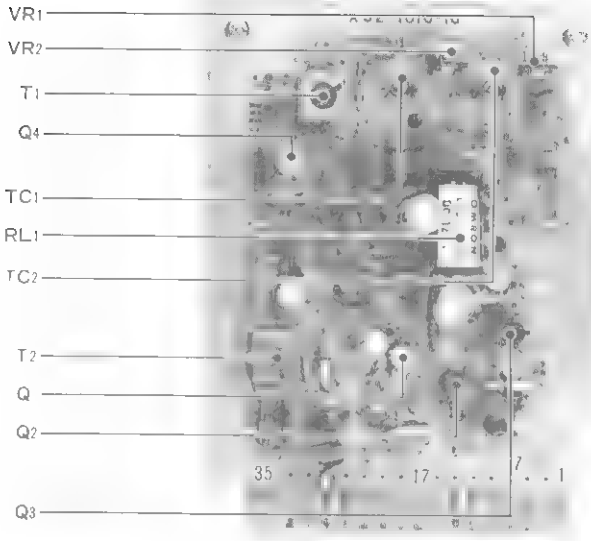



FIGURE 16. GEN Board

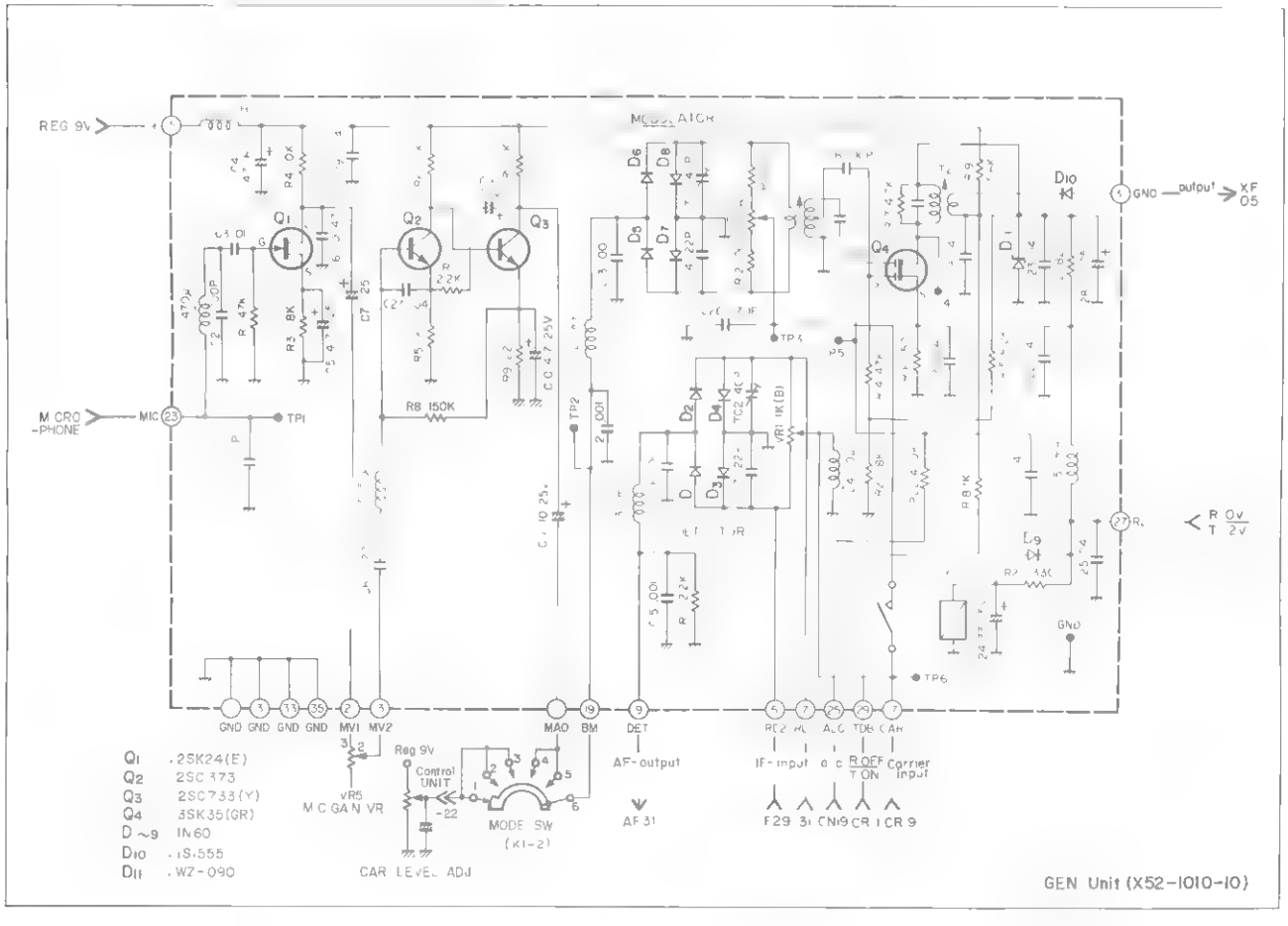



FIGURE 17. GEN Schematic

## 5.5 XF (Crystal Filter) BOARD (X51-1010-10) (See Figure 18)

This circuit filters one of the sidebands from the DSB signal from the generator unit. The circuit employs a 3 MHz band crystal filter. Separate USB and LSB filters keep the carrier frequency unchanged (3.395 MHz) between sidebands.

The USB filter serves as the CW filter when the optional CW filter is not used.

The optional CW filter can be easily inserted into the circuit when desired.

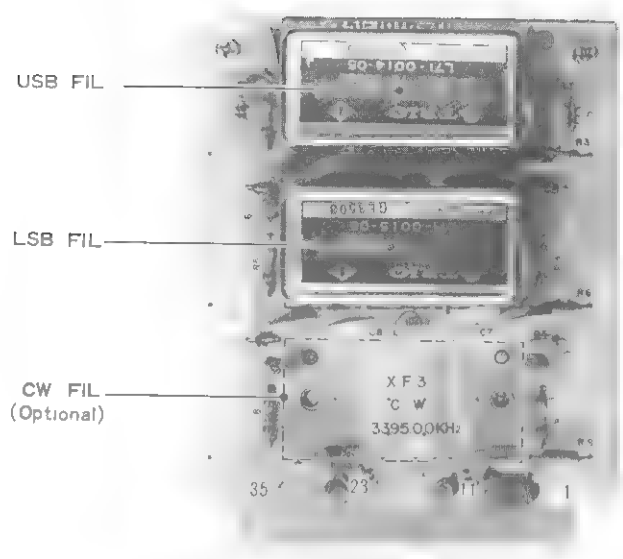



FIGURE 18. XF Board

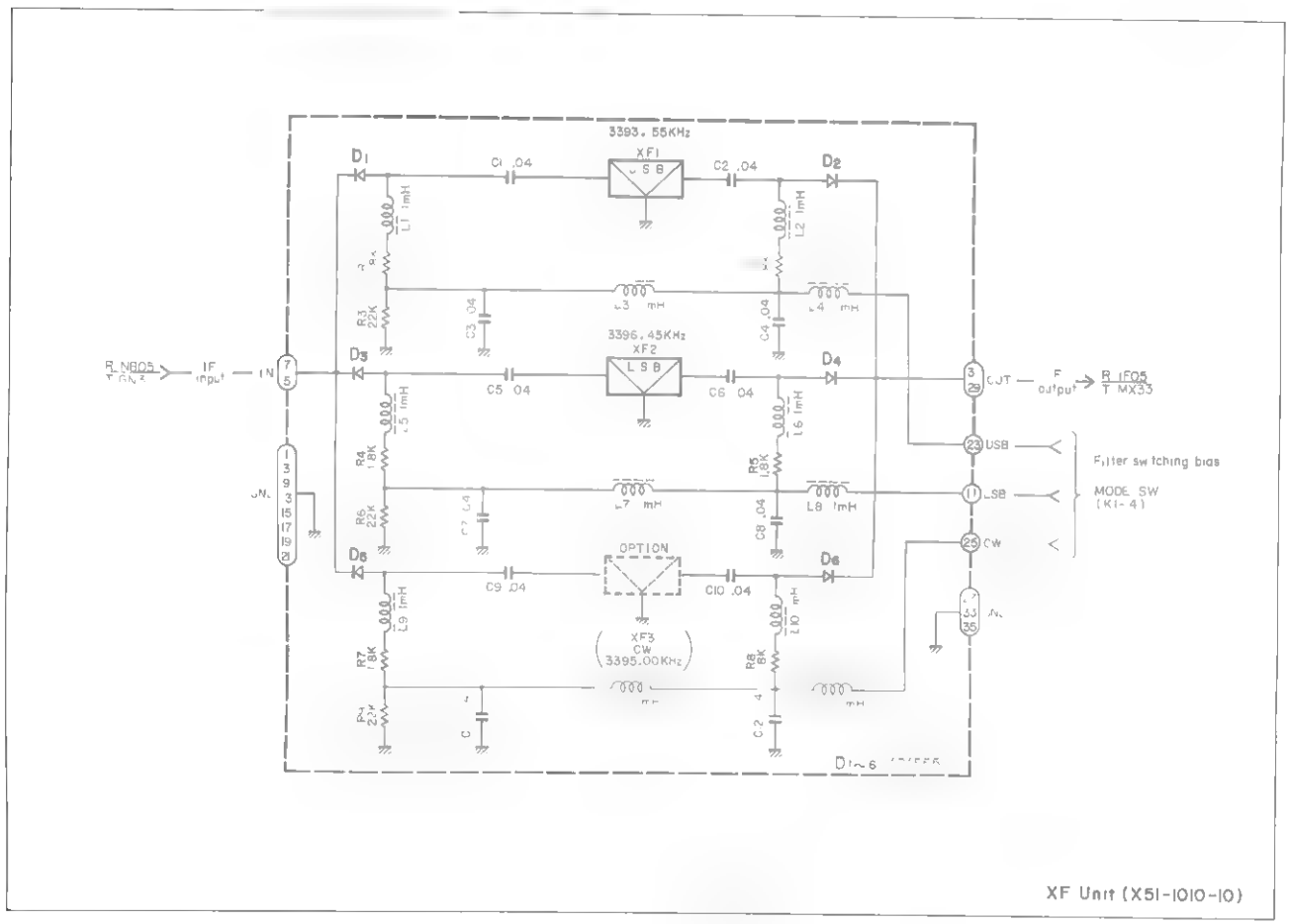



FIGURE 19. XF Schematic

## 5.6 NB (Noise Blanker) BOARD (X54-1040-10) (See Figure 20)

The noise blanker is designed to remove pulse noises from received signals. The circuit switches closed during the noise impulses and switches open when noise impulses are not present. The gate opens and closes fast enough so that the ear hears an uninterrupted audio signal.

The receiver's second IF signal, from the MIX board, passes through the input filter of the NB board and is amplified by transistor Q7. The signal then feeds to the XF board.

When the NB switch is turned on, the signal (amplified by Q8 and Q9) is separated into signal and noise components. The noise component (shaped into a suitable waveform by Q4, Q5 and Q6) triggers the blanking gate diodes, D3 and D4. When the diodes are triggered, the signal path is closed. In this manner most of the impulse noise is blocked out, leading to higher receiver intelligibility.

Transistor Q2 is an AGC amplifier for the IC circuit.

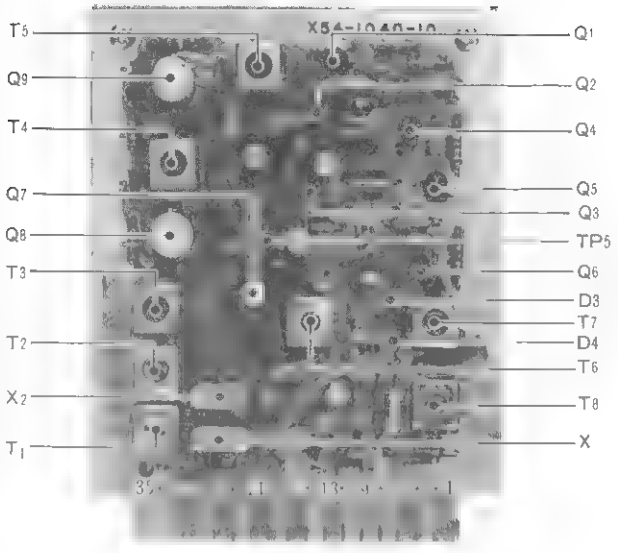



FIGURE 20. NB Board

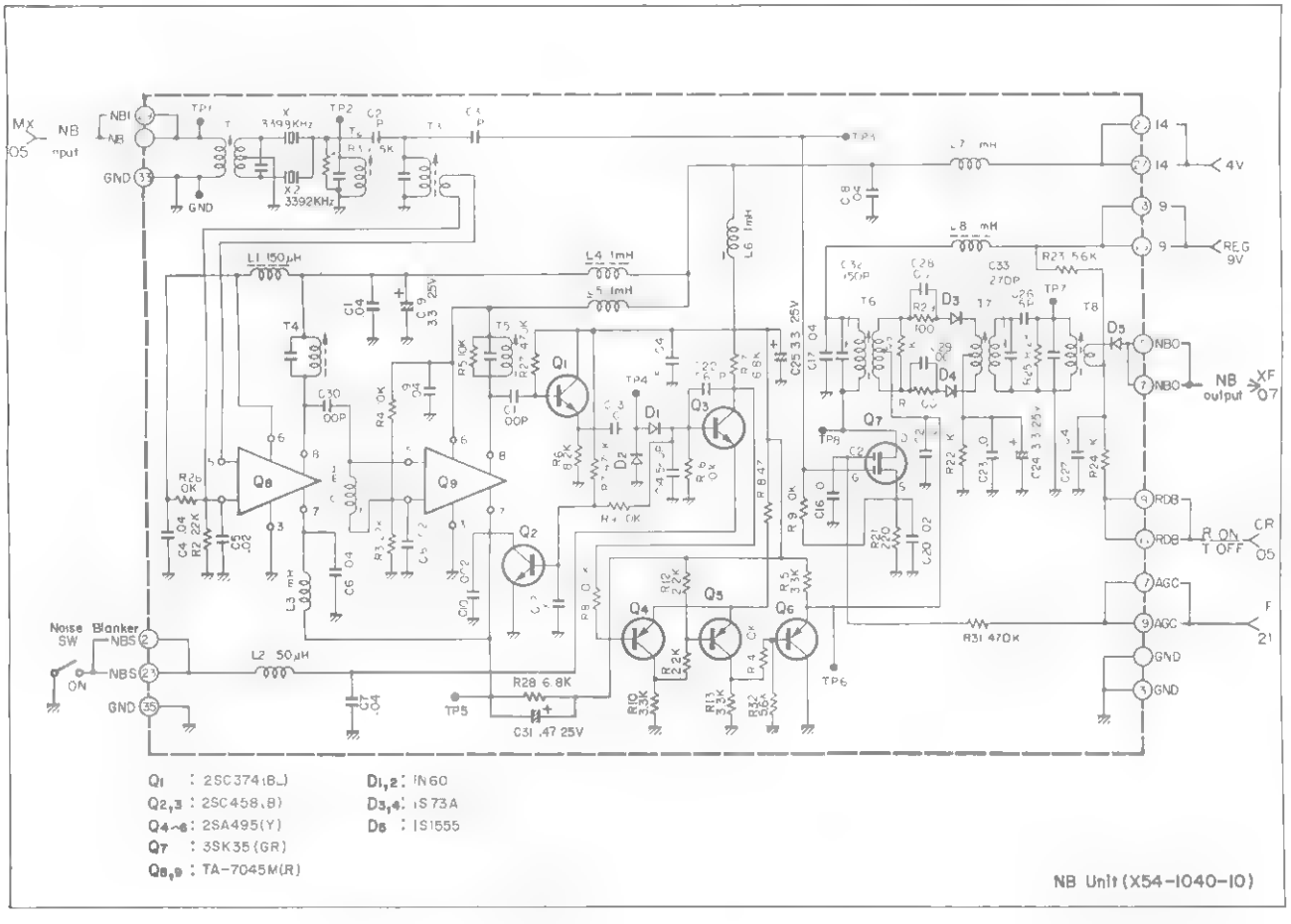



FIGURE 21. NB Schematic

## 5.7 IF BOARD (X48-1010-10) (See Figure 22)

The IF circuit operates only during reception. Transistors Q1 and Q2 amplify the receiver's second IF signal, coming from the XF board, and pass the signal to the balanced detector.

The board also holds the S-meter amplifier, Q3 and Q4, and the time-constant circuit, Q5 and Q6, which controls the AGC.

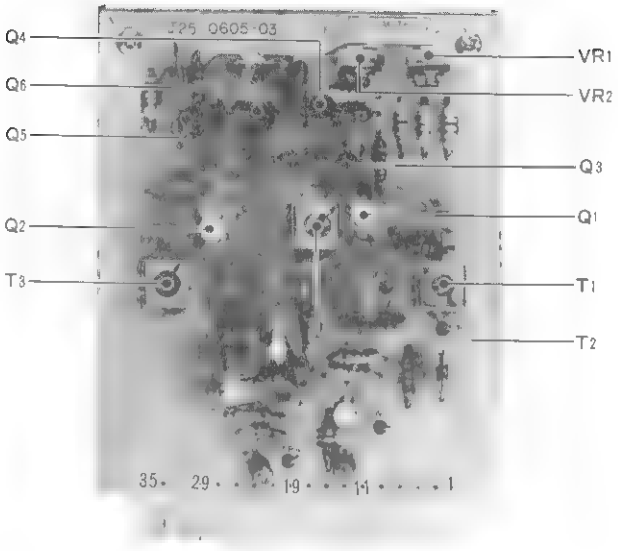



FIGURE 22. IF Board

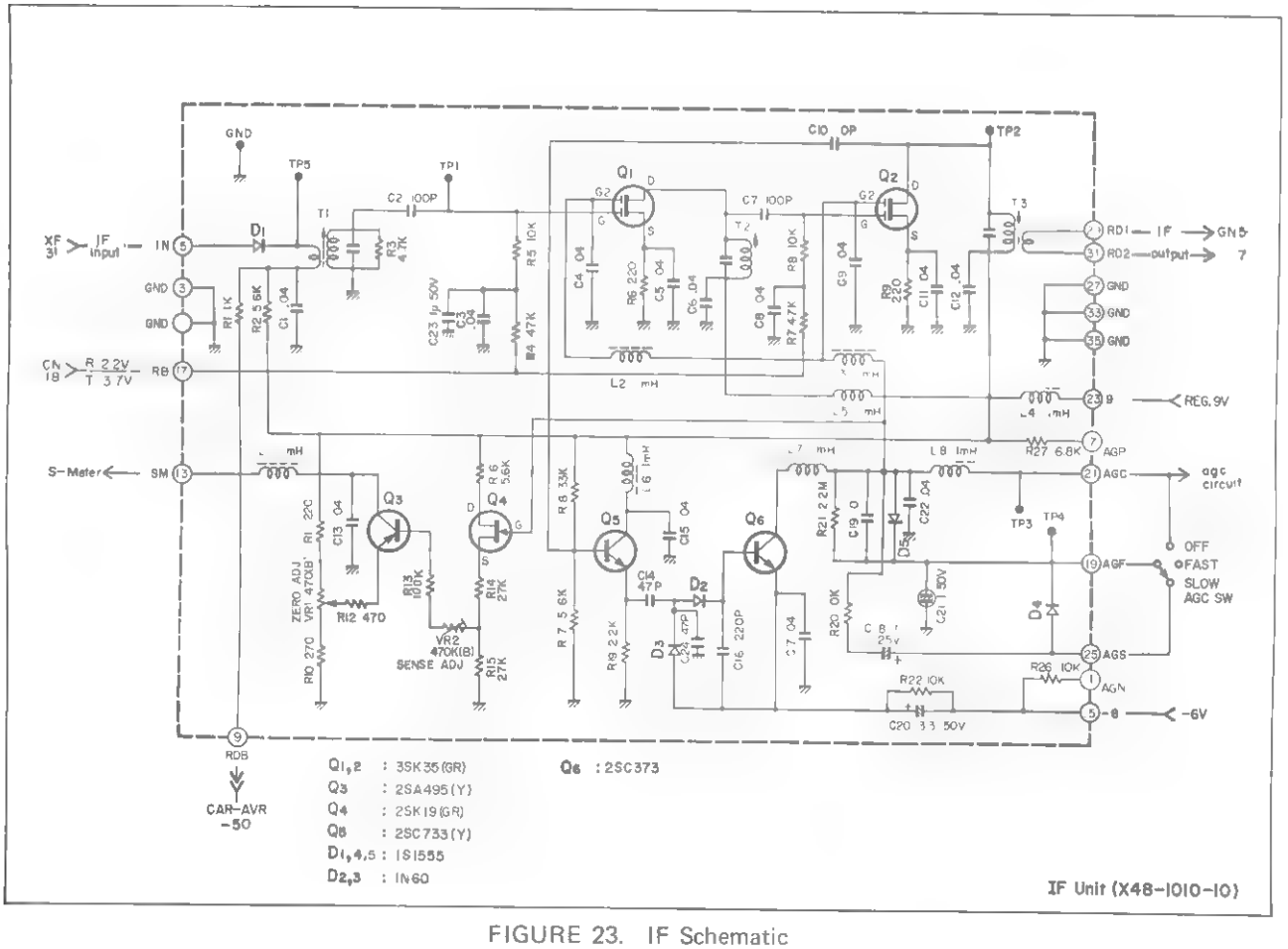



FIGURE 23. IF Schematic

## 5.8 MIX (Mixer) BOARD (X48-1020-10) (See Figure 24)

Transistor Q2 acts as the first transmitter mixer. It mixes the transmitter's first IF signal (from the XF board) and the VFO output to generate the transmitter's second IF signal (8 MHz range).

Transistor Q3 acts as the second receiver IF mixer. It converts the 8 MHz first receiver IF signal to a 3.395 MHz second receiver IF signal. The VFO input is injected into the mixer through a 3 section LC low-pass filter to eliminate harmonics.

The transmit output and receive input circuits include an electronic tuner (VCT) which uses a variable capacitance diode, D1.

Q4 and Q5 monitor the ALC voltage for the ALC meter reading. Q6 and Q7 are a detector circuit to detect RF AGC voltage. Q8 and Q9 are a lamp indicator circuit to control the switch lamps for the external VFO switching.

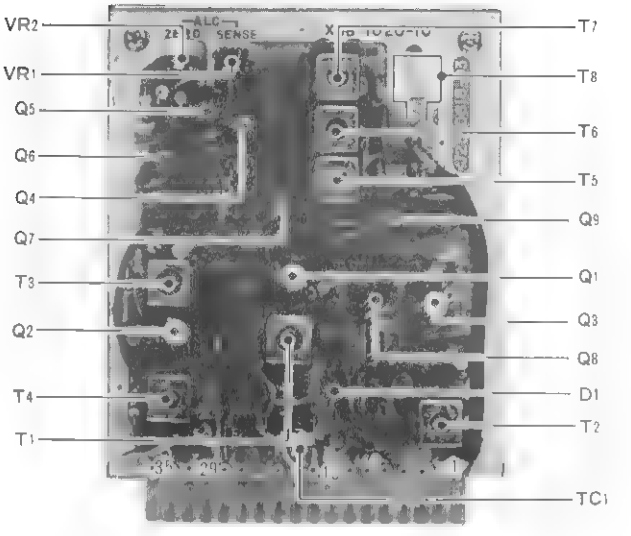



FIGURE 24. MIX Board

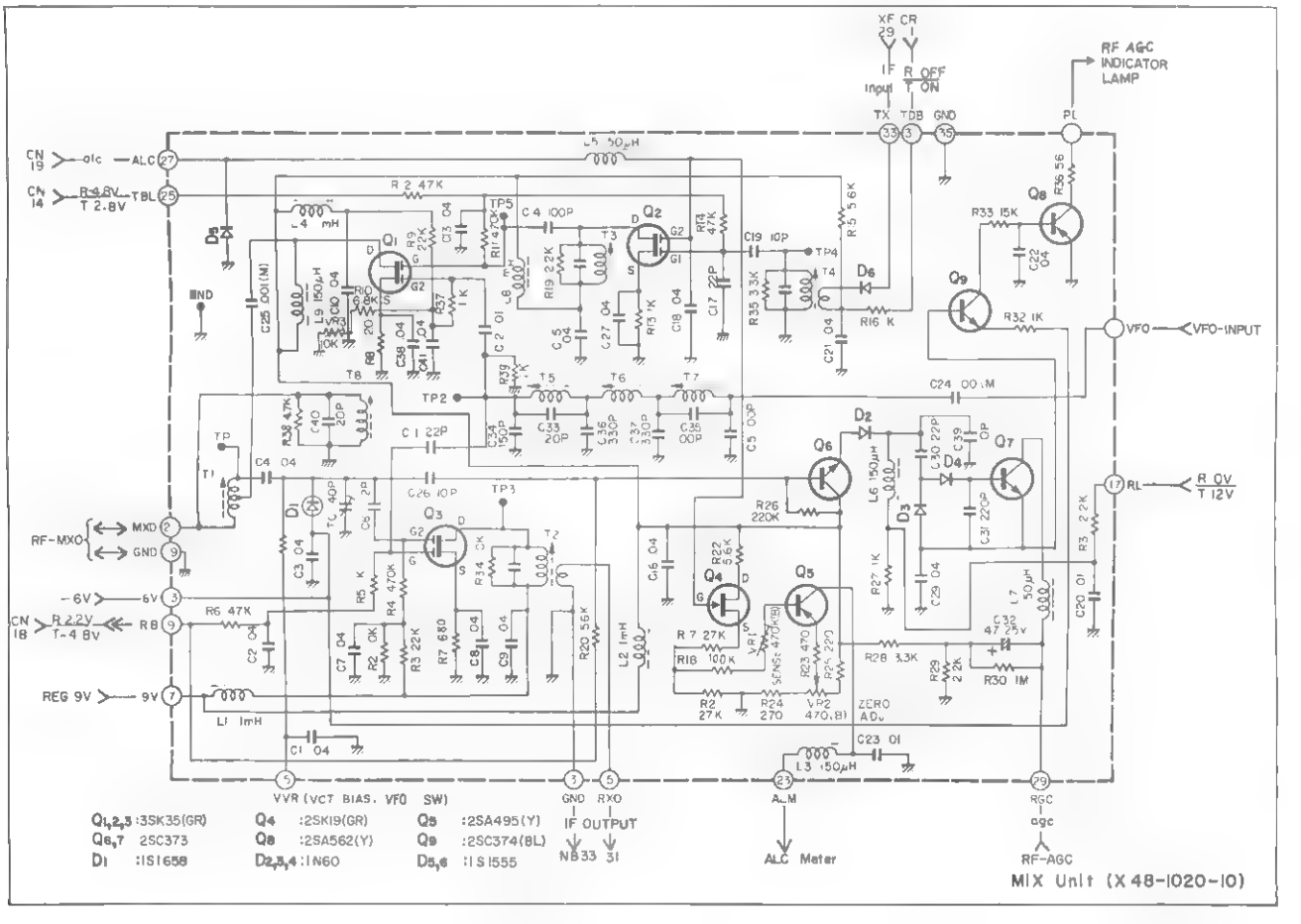



FIGURE 25. MIX Schematic

## 5.9 AF BOARD (X49-1020-10) (See Figure 26)

The AF board is the final stage of the receiver section. The circuit includes a low-pass filter (Q1 and Q2), a complimentary amplifier (Q6 and Q7), and a driver amplifier (Q4 and Q5). The output impedance can be selected at 8 ohms or 600 ohms.

A side-tone generator circuit, to monitor CW transmissions, is also included on the AF board.

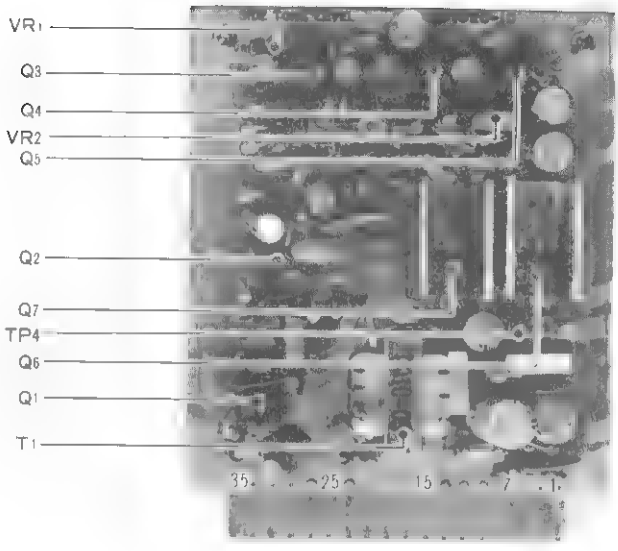



FIGURE 26. AF Board

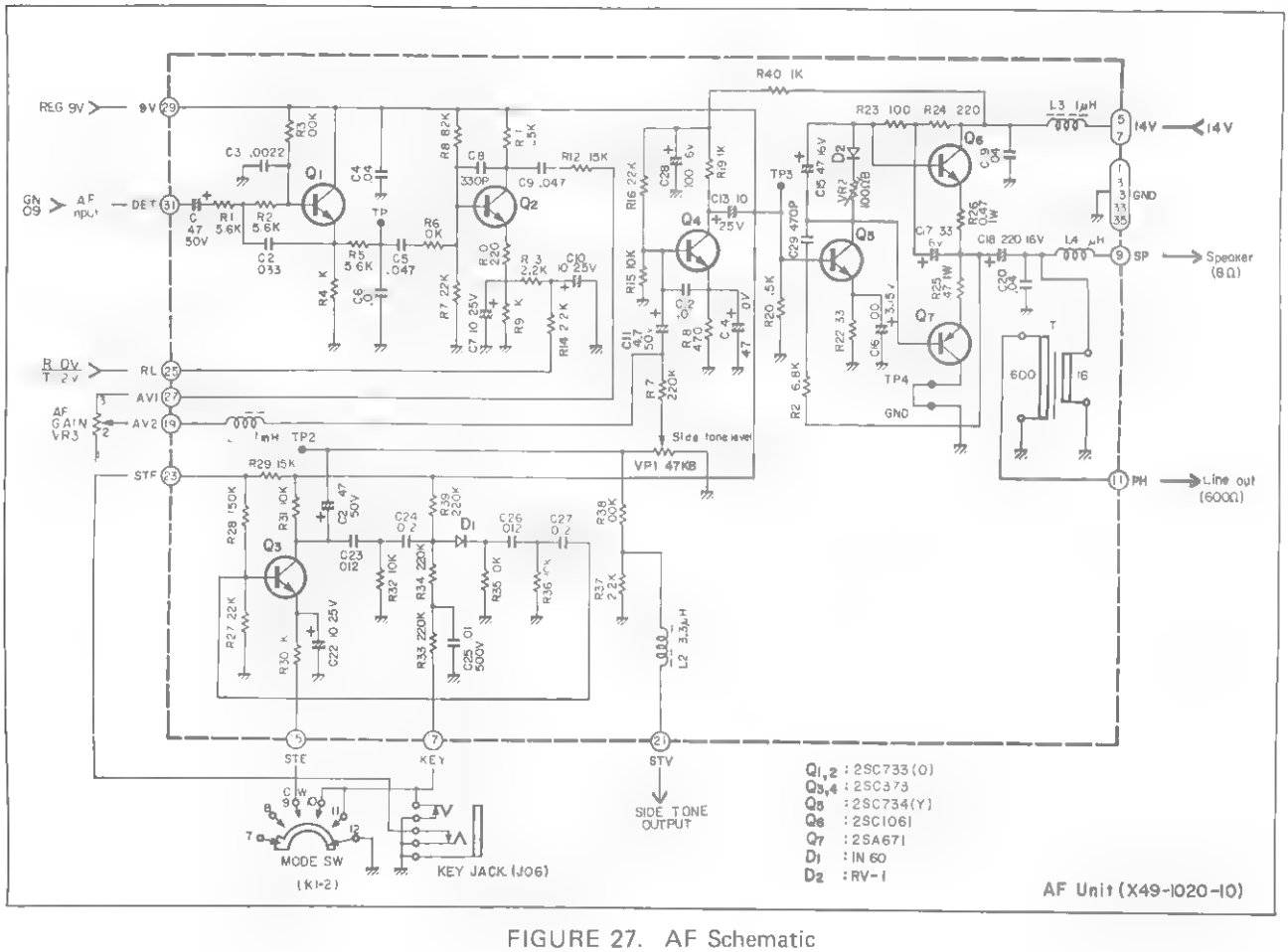



FIGURE 27. AF Schematic

## 5.10 CONT (Control) BOARD (X53-1010-10) (See Figure 28)

The control board holds many of the circuits used to control the TS-900. Q1 is the ALC amplifier, Q3 is an amplifier for the IP meter reading, and Q4 and Q5 are a TB/RB switch to switch between transmit and receive voltages.

The TB/RB switch controls the bias supply voltages to the MIX and IF boards to disconnect the transmit sections during receive, and to disconnect the receive sections during transmit.

VR1 is the carrier level adjustment. Turn this control to adjust the plate current to the proper level for CW operation.

VR2 is the RIT zero adjust control. Turn VR2, if necessary, so that the RIT zero is at a receive frequency exactly the same as the TS-900 transmit frequency.

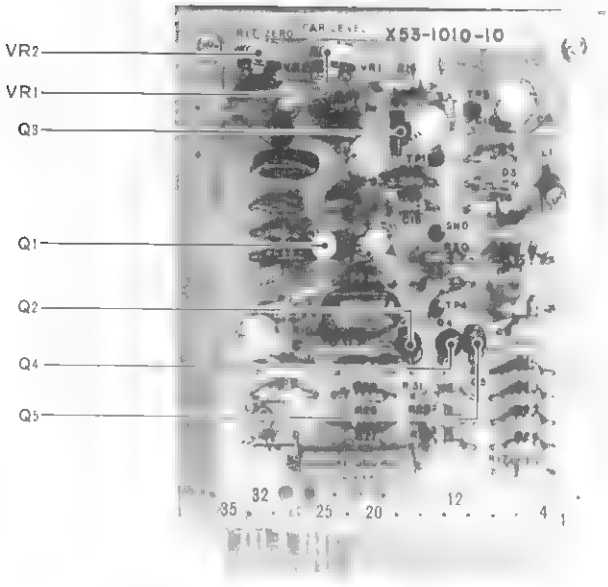



FIGURE 28. CONT Board

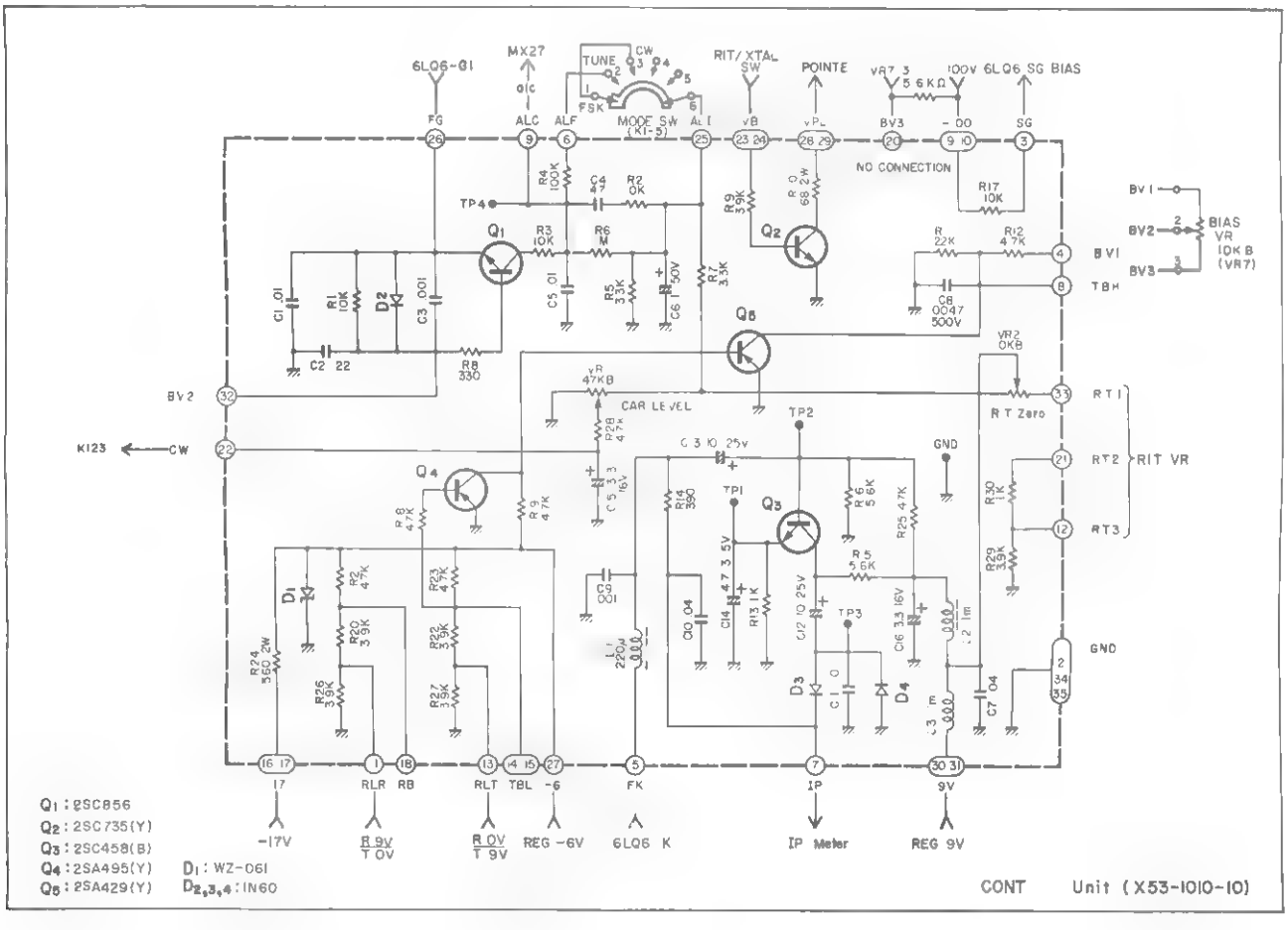



FIGURE 29. CONT Schematic

## 5.11 VOX-MKR (VOX-Marker) BOARD (X54-1020-10) (See Figure 30)

### VOX CIRCUIT

The VOX circuit amplifies the audio input and the AF output, and controls transistor Q8 which drives the T/R relay. When the stand-by switch is in the SEND position, Q7 is turned off and Q8 is turned on. Turn VR1 to adjust the time constant of the circuit. Transistor Q5 controls the time constant of the circuit.

### MKR CIRCUIT

To calibrate the TS-900, transistor Q12 pulls a harmonic frequency component from the 100 KHz crystal oscillator. When the MS terminal is grounded, Q10 and Q11 divide the 100 KHz signal into 25 KHz divisions.

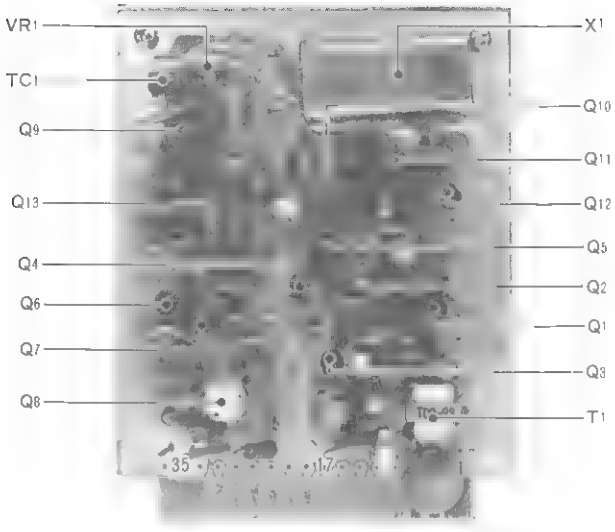



FIGURE 30. VOX-MKR Board

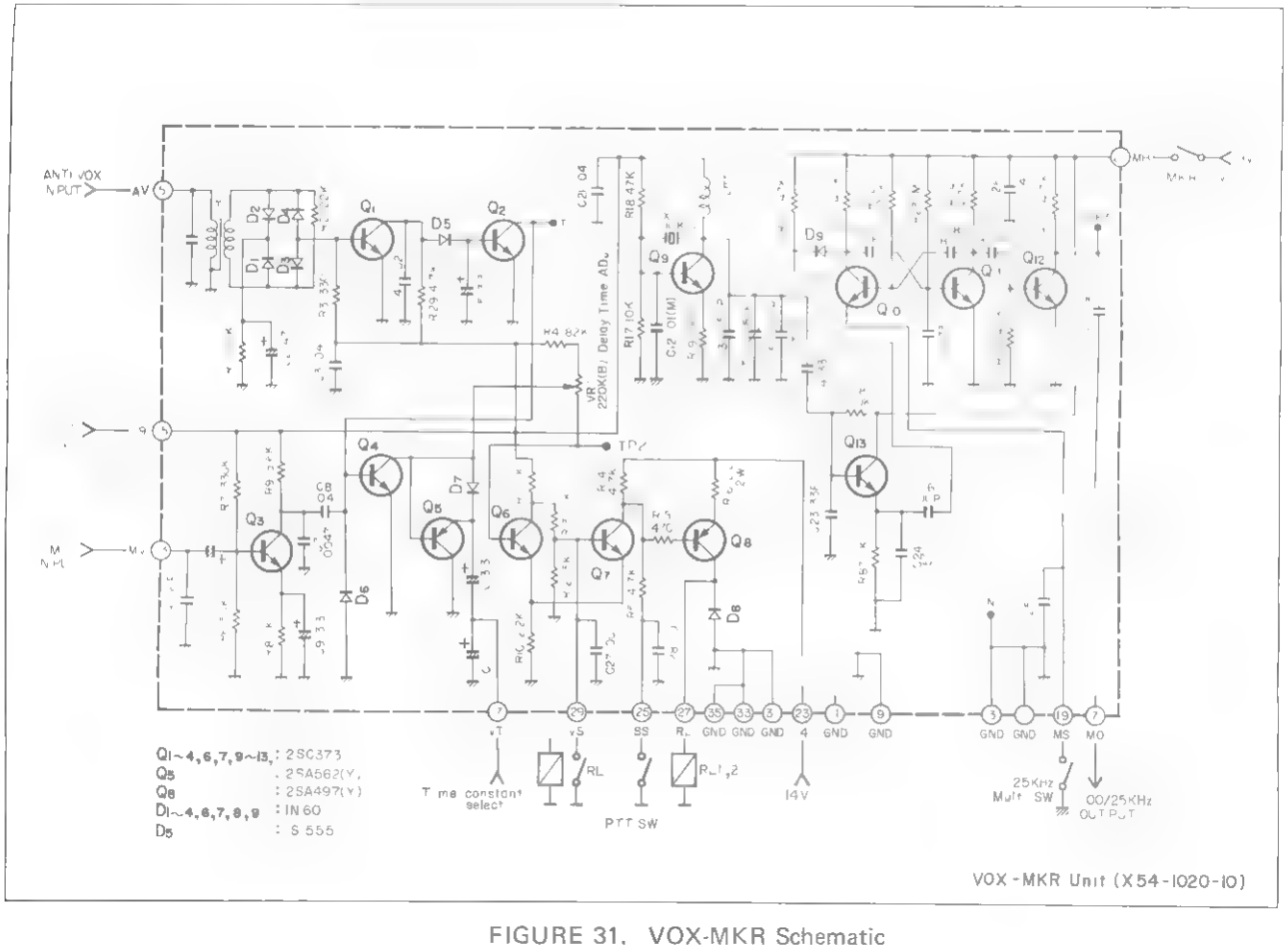



FIGURE 31. VOX-MKR Schematic

## 5.12 FIX (Fixed Channel Oscillator) BOARD (X50-1120-10) (See Figure 32)

This board holds a crystal-controlled oscillator which can be used in place of the VFO to operate the transceiver on a fixed channel.

To install the crystals, remove the two screws which hold the FIX board, then carefully lift the board from the transceiver while exercising care.

Refer back to Section 4.14 for crystal specifications and operating instructions. Trimmers TC1 (Channel 1) and TC2 (Channel 2) should be used, if necessary, to net the crystals exactly on frequency. VR1 (Channel 1) and VR2 (Channel 2) should be adjusted for maximum output. If the crystal does not oscillate, adjust TC4.

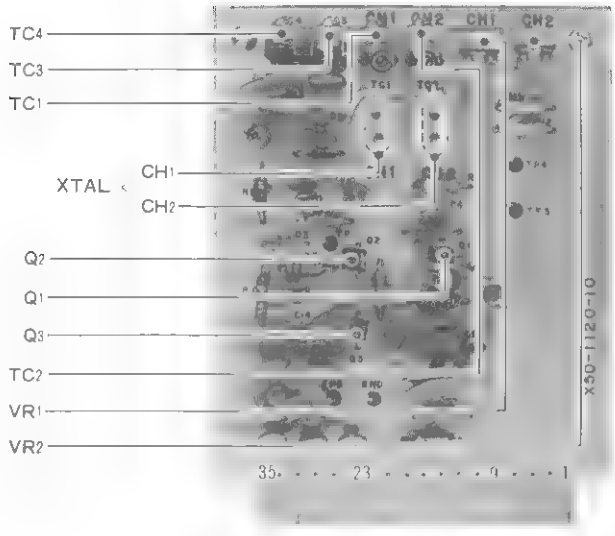



FIGURE 32. FIX Board

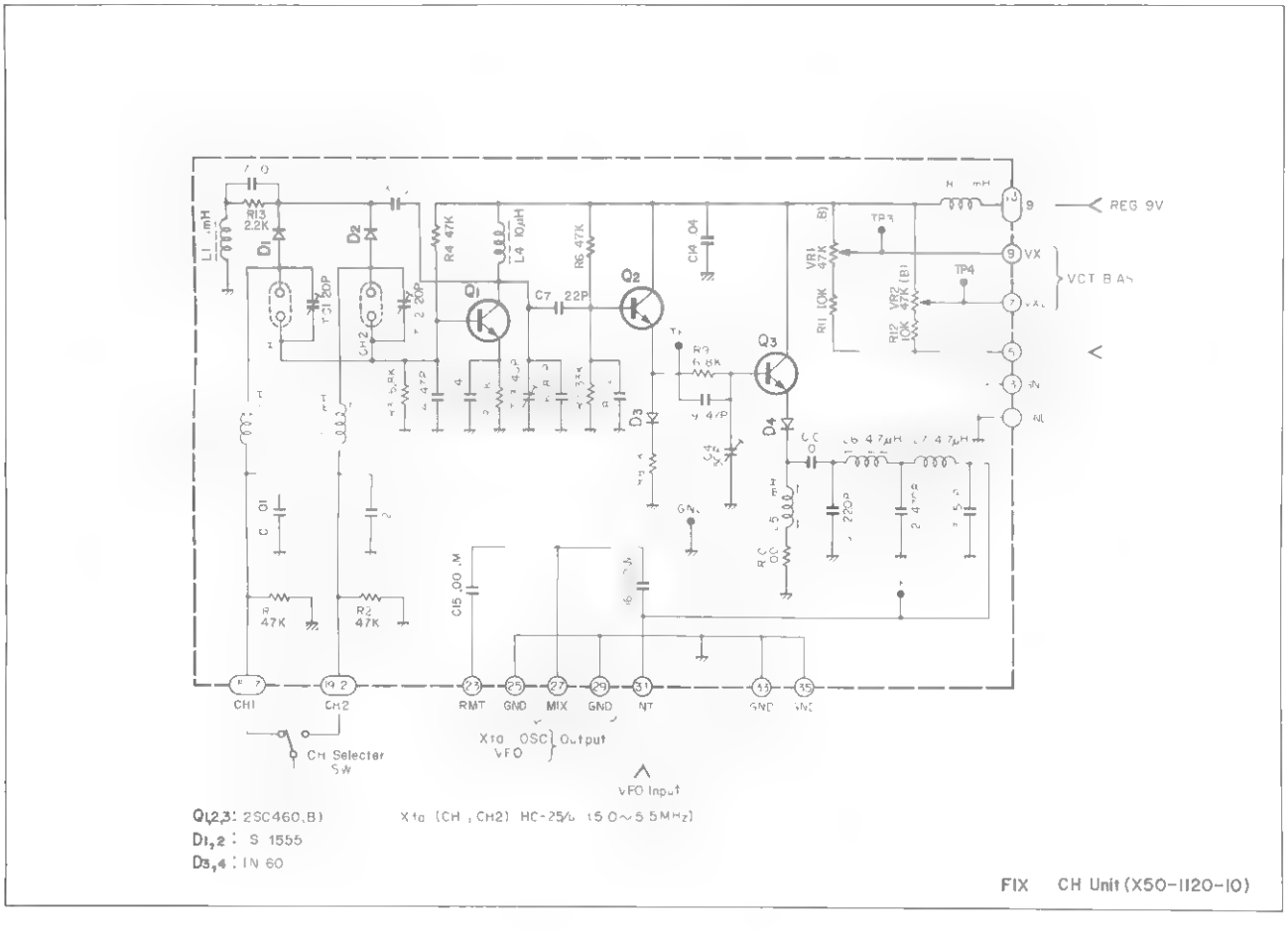



FIGURE 33. FIX Schematic

## 5.13 RF SECTION (X44-1020-10) (See Figure 34)

The RF amplifier stage of the TS-900 is part of the RF section. The RF section includes four coil-pack circuit boards which are interconnected by an 18-prong connector.

The transmitter's second IF signal is mixed with the output of the heterodyne oscillator to produce the final frequency. This signal is amplified by V1 (6GK6) to drive the two 6LQ6 final power tubes.

Received signals are amplified by transistor Q3, and heterodyned by transistor Q2 to the receiver's first IF signal.

The input and output of the RF section are coupled to the MIX board through a tuner which uses a voltage variable capacitor.

### HET OSC (Heterodyne Oscillator) Board (X50-1040-10) (See Figure 35)

This circuit employs a crystal and an FET (Q1) to generate a stable oscillator output. This output is fed through a buffer amplifier (Q2 and Q3) to the heterodyne mixer.

### MIX COIL BOARD (X44-1030-10) (See Figure 36)

This board holds the tuning coils for heterodyning in transmit and receive.

### ANT COIL BOARD (X44-1040-10) (See Figure 37)

This board holds the front-end coils of the receiver section.

### DRIVE COIL BOARD (X44-1050-10) (See Figure 38)

This board holds the transmitting coils. The board serves as a load for the 6GK6 driver and as a driver for the two 6LQ6 final tubes. There is no WWV coil for the transmitter section.

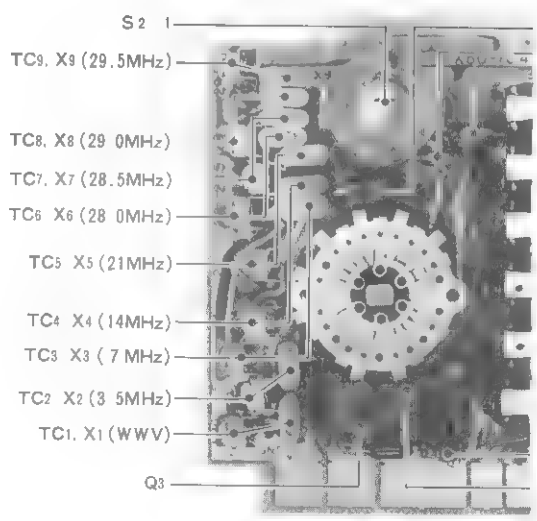



FIGURE 35. HET OSC

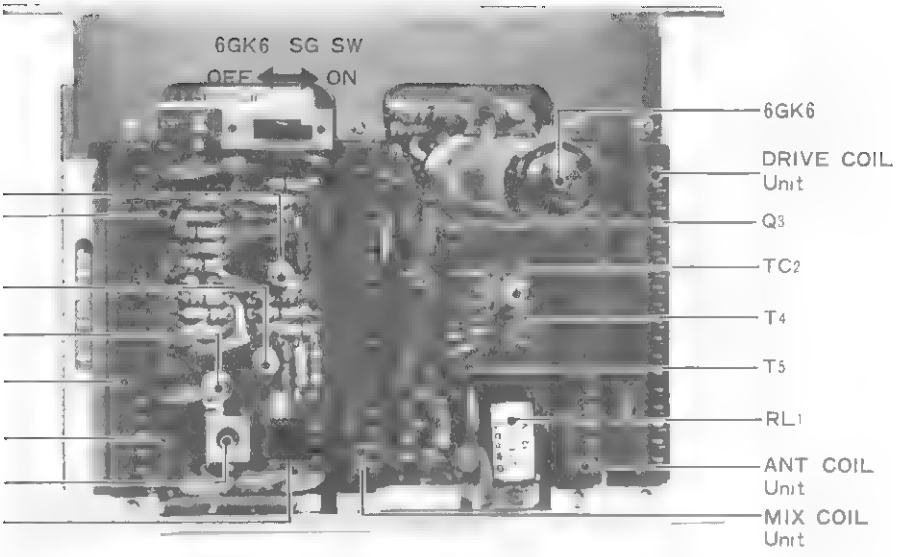
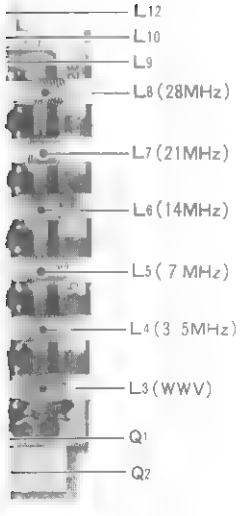



FIGURE 34. RF Section Board




Board

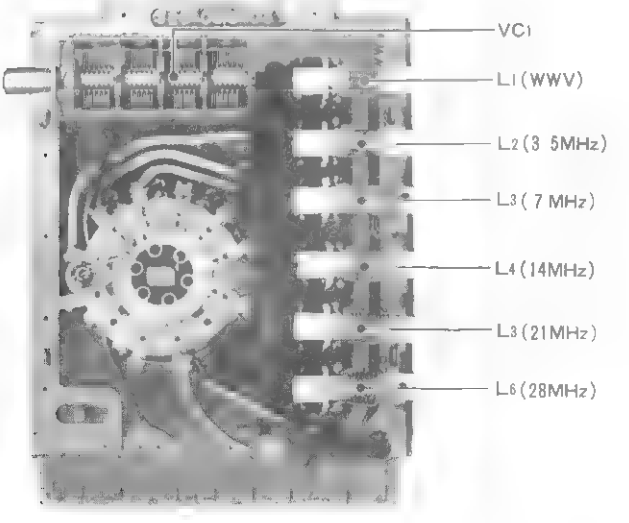



FIGURE 36. MIX Coil Board

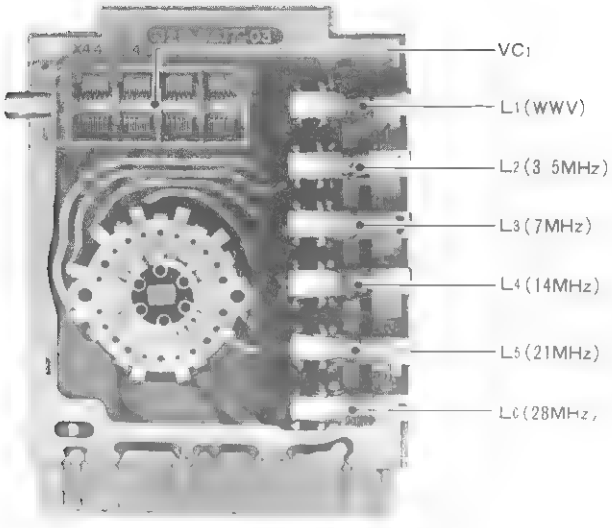
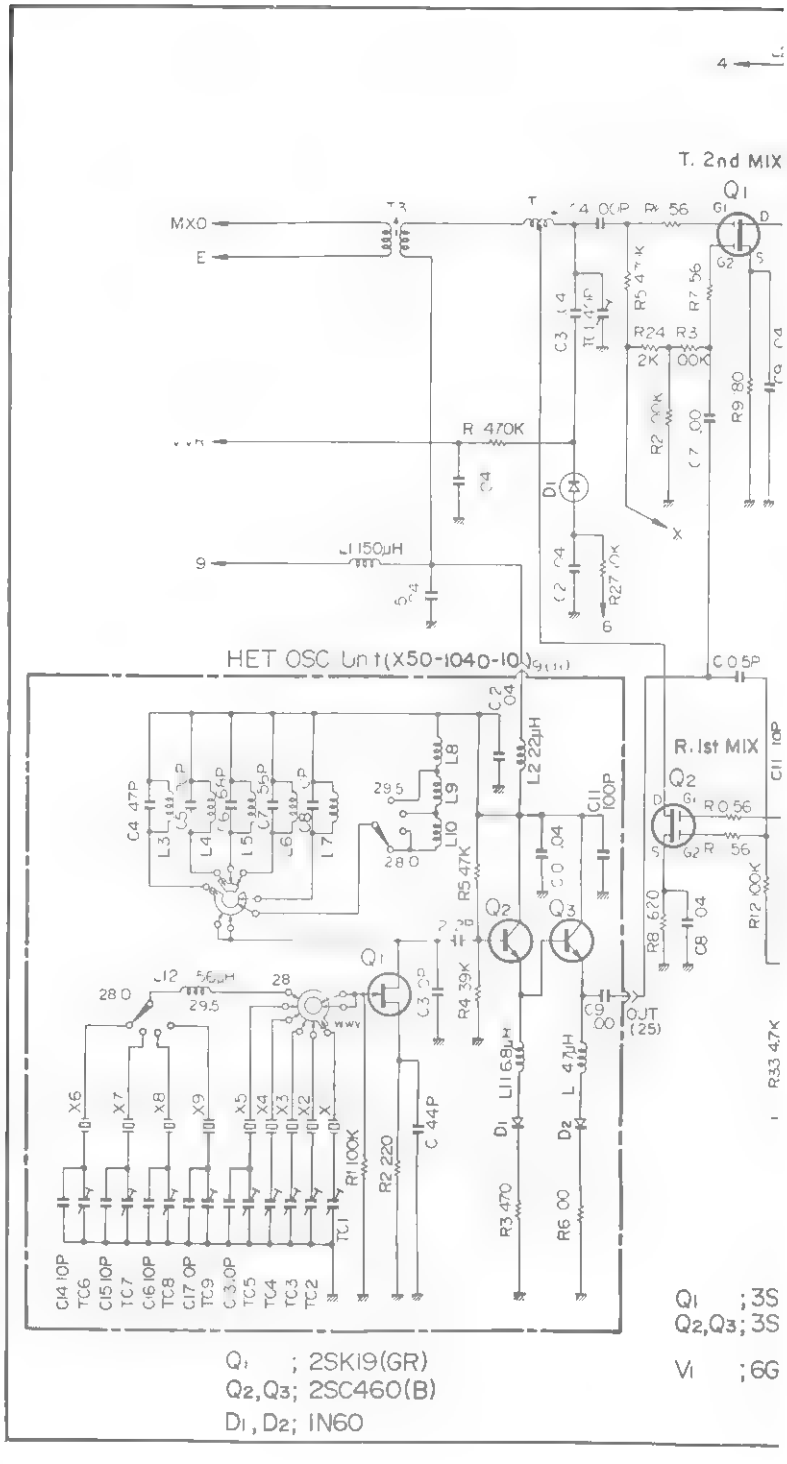



FIGURE 37. ANT Coil Board



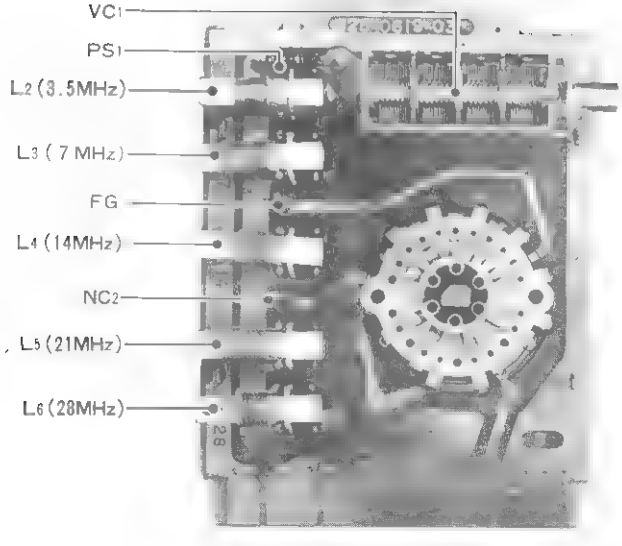
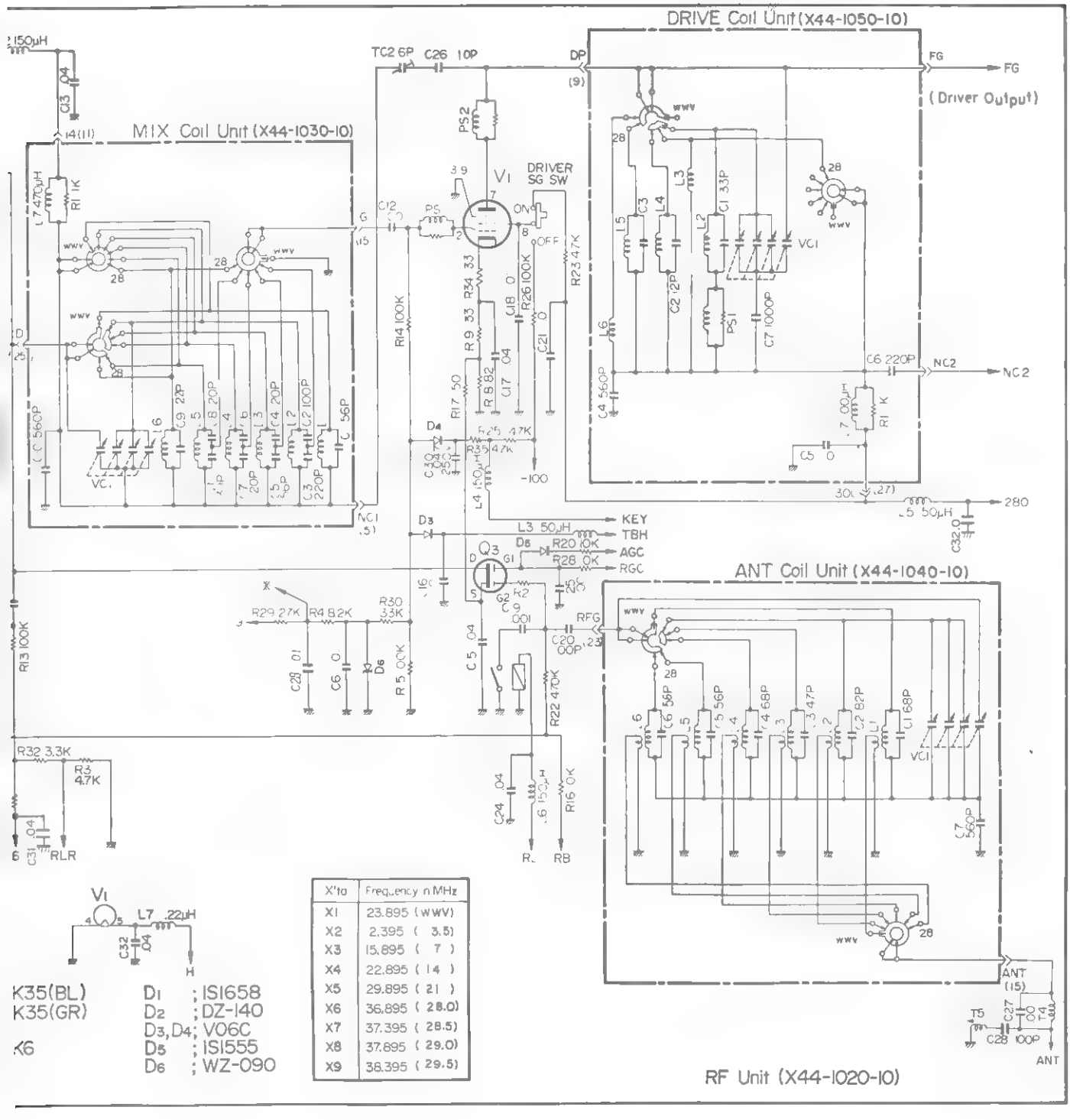




FIGURE 38. DRIVE Coil Board




| X'tal | Frequency in MHz |
|---|---|
| X1 | 23.895 (WWV) |
| X2 | 2.395 ( 3.5) |
| X3 | 15.895 ( 7 ) |
| X4 | 22.895 ( 14 ) |
| X5 | 29.895 ( 21 ) |
| X6 | 36.895 ( 28.0) |
| X7 | 37.395 ( 28.5) |
| X8 | 37.895 ( 29.0) |
| X9 | 38.395 ( 29.5) |

FIGURE 39. RF Section Schematic

# SECTION 6. MAINTENANCE AND ALIGNMENT

CAUTION

*DANGEROUS HIGH VOLTAGES ARE PRESENT WITHIN THE CASE OF THE TS-900 WHEN THE TRANSCEIVERS IS TURNED ON EXERCISE EXTREME CAUTION TO AVOID ELECTRIC SHOCK.*

## 6.1 GENERAL INFORMATION

### REMOVING THE TOP COVER (See Figure 40)

Unscrew the single screw holding the top cover. Pull each of the black plungers up and draw the cover upwards and towards the front of the transceiver.

### REMOVING THE CABINET (See Figure 40)

Remove the necessary screws, and pull off the case as shown. The four legs need not be removed.

### SERVICE POSITION (See Figure 41)

The TS-900 should be placed on its side for any alignment or service. This position permits adequate ventilation for the final tubes as well as easy accessibility to the plug-in modules. Most of the described adjustments can be made without removing the boards from the transceiver.

Figure 42 shows how to remove the boards. To service a board while it is in the TS-900 you must take the module out of the transceiver first. After removing the chassis shield over the section to be serviced, remove the screws holding the board to the chassis. The module pulls straight out from the transceiver, however sometimes gently rocking the board makes removal easier.

After pulling the module, look to the opposite side of the equipment to find the connector which held the module in place. One side of the connector is hinged to the chassis and the other side is connected to the chassis with a screw. Remove the screw and swing the connector out of the chassis (see Figure 41). Finally reinsert the board into the connector.

NOTE

*Be sure the board is correctly oriented. The soldered side of the board should face the back of the transceiver.*

## 6.2 RECEIVER ALIGNMENT

The stand-by switch of the transceiver should be in the REC position during all of the receiver adjustments.

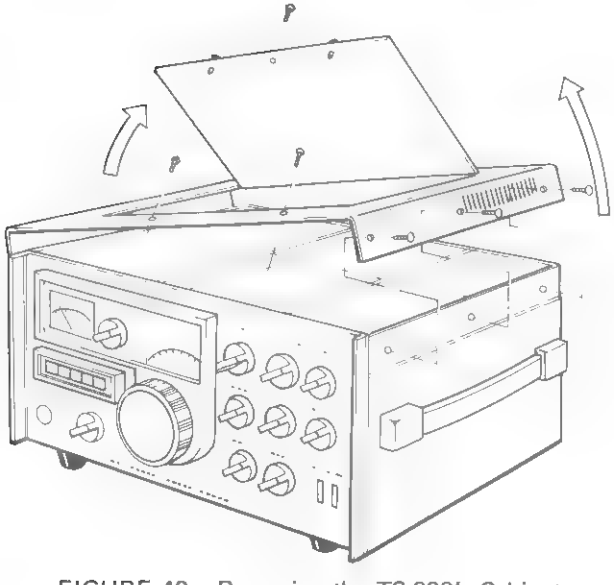


FIGURE 40. Removing the TS-900's Cabinet

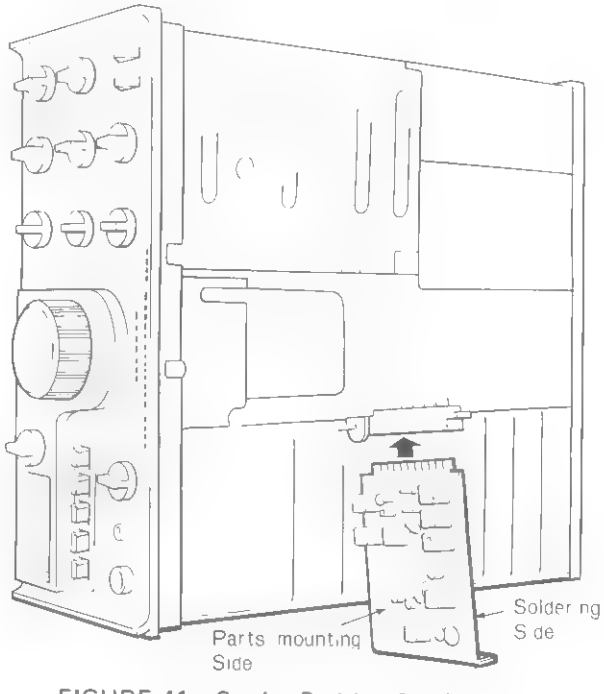



FIGURE 41. Service Position for the TS-900

## COIL PACK

Turn the CAL switch to the 25K position and use the output of the calibrator circuit to adjust the coils. The DRIVE control should be set to the 12 o'clock position (the white line pointing towards the top of the transceiver). The coils can be aligned from the bottom of the transceiver without removing the boards.

Set the BAND switch to the correct band and tune the VFO to the frequency shown in Table 6 to receive the calibrator signal. Use the test rod included in the accessory bag to tune the appropriate antenna coils for a maximum S-meter reading. Figure 43 shows the location of the coils. Adjust the coils for each band as described in Table 6. When you finish, turn the calibrator off.

**TABLE 6. ANT, MIX, and DRIVE Board Coil Alignment**

| Adjusting Order | Band | Alignment Frequency |
|---|---|---|
| 1 | 3.5 MHz | 3.750 MHz |
| 2 | 7.0 MHz | 7.150 MHz |
| 3 | 14.0 MHz | 14.175 MHz |
| 4 | WWV | 15.250 MHz |
| 5 | 21.0 MHz | 21.225 MHz |
| 6 | 28.0 MHz | 28.900 MHz |

**CAUTION**

*The antenna cores are fragile. Be careful not to break them during alignment.*

The coils for each band should be adjusted in the order given above.

## HETERODYNE CRYSTAL OSCILLATOR

Adjust the heterodyne crystal oscillator's coils by switching the BAND switch to each band and tuning the appropriate coil (see Figure 43) as described below.

Turn the core of the coil counter-clockwise until the crystal stops oscillating. You should be able to hear the point where this happens. From the point where the crystal stops oscillating, turn the core about one revolution clockwise so that the crystal is again oscillating. If the core is left too near the threshold the oscillation may be unstable. Repeat the procedure for each band. For the 28 MHz band only the 28.5 MHz sub-band needs to be tuned.

Connect a frequency counter to TP1 in the RF section (See Figure 45). During the alignment described above, after

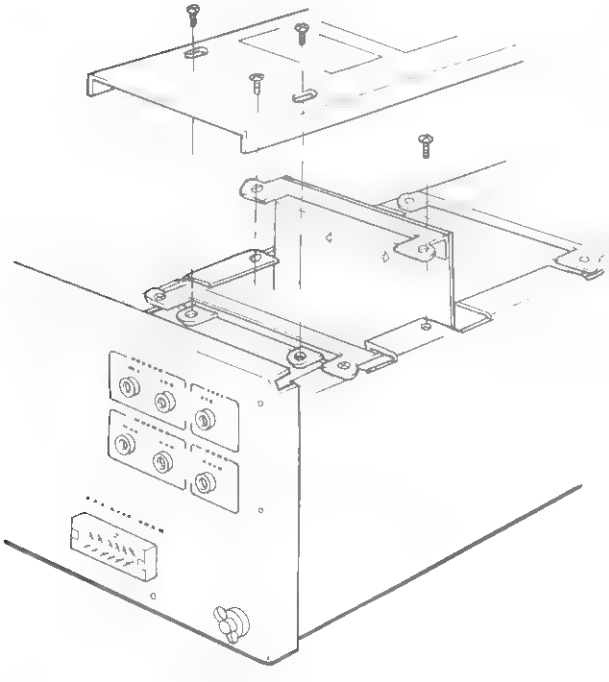
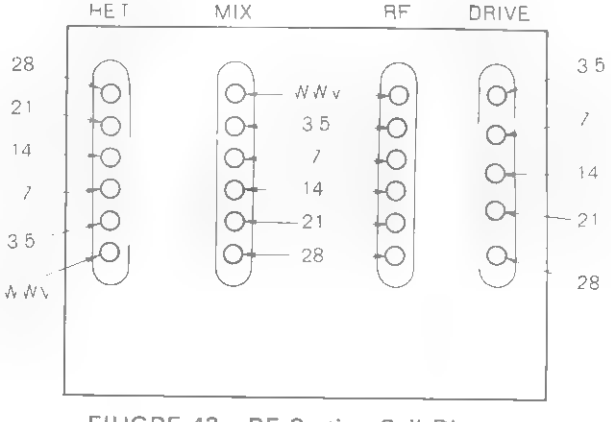


FIGURE 42. How to Remove a Board




FIUGRE 43. RF Section Coil Diagram

each coil is adjusted, adjust the trimmer on the opposite side of the board for the frequencies shown in Table 7.

The trimmers, like the coils, are arranged (right to left) from WWV, 3.5, up to 29.5 MHz.

**TABLE 7. Heterodyne Oscillation Alignment Frequencies**

| BAND | Frequency at TP 1 |
|---|---|
| WWV | 23.895 MHz |
| 3.5 MHz | 12.395 MHz |
| 7 MHz | 15.895 MHz |
| 14 MHz | 22.895 MHz |
| 21 MHz | 29.895 MHz |
| 28 MHz | 36.895 MHz |
| 28.5 MHz | 37.395 MHz |
| 29.0 MHz | 37.895 MHz |
| 29.5 MHz | 38.395 MHz |

## 6.3 CAR-AVR BOARD ADJUSTMENTS

### ADJUSTING POWER VOLTAGE

The voltage can be adjusted from the top of the TS-900 or by swinging the CAR-AVR board out of the chassis as described in Section 6.1. Keep the stand-by switch in the REC position.

When adjusting the 9 volt DC voltage with the board still in the transceiver, attach a DC voltmeter to either pin 27 or to pin 29 of the board's connector. Turn VR1 (see Figure 14) to adjust the voltage to 9 volts ±0.2 volts.

When adjusting the voltage with the board swung out of the chassis, attach the DC voltmeter to TP2 (see Figure 14). Turn VR1 to adjust the voltage to 9 volts ±0.2 volts

### CARRIER OSCILLATOR FREQUENCY

Connect a frequency counter to TP1 (see Figure 14). Set the MODE switch to USB and adjust trimmer TC2 (on the CAR-AVR board) until the frequency counter reads 3.395 MHz. The stand-by switch is still in the REC position.

Set the MODE switch to FSK and adjust trimmer TC1 (on the CAR-AVR board) for a frequency counter reading of 3.39415 MHz.

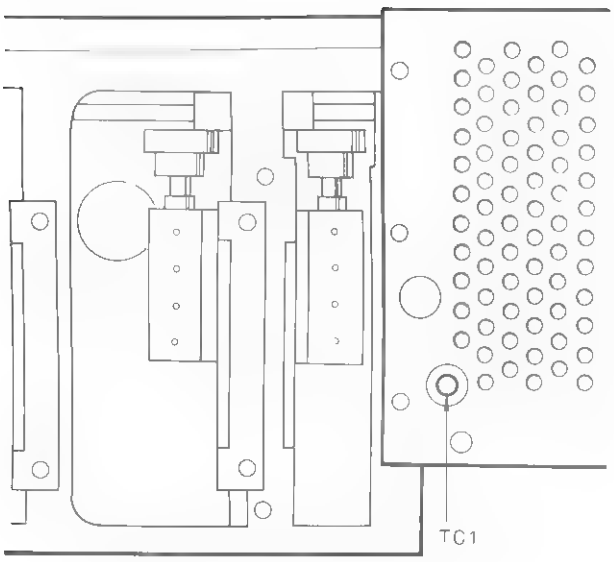



FIGURE 44. Final RF Section

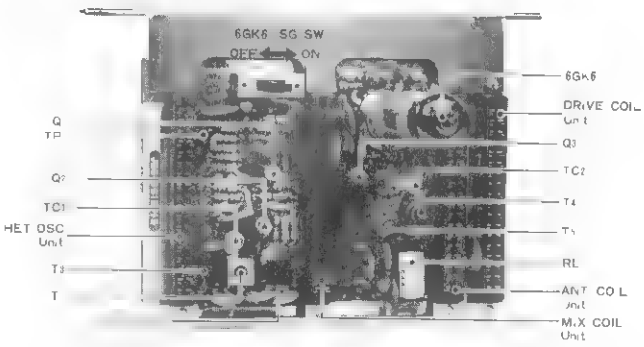



FIGURE 45. DRIVE Board

Leave the MODE switch at FSK and slide the SG switch to OFF. Flip the stand-by switch to SEND. Connect a key to the RTTY jack and close the key. Adjust trimmer TC3 for a frequency counter reading of 3.396725 MHz. Open the key and adjust trimmer TC4 for a frequency counter reading of 3.397125. If a frequency shift other than 850 Hz is desired, use the same procedure to adjust the trimmer for the desired frequency shift. Be sure to put the stand-by switch back in the REC position and to turn the SG switch back on when you are finished.

## 6.4 OTHER RECEIVER CIRCUITS

To finish aligning the receiver section, make the following adjustments along the received signal's path.

With the stand-by switch in the REC position, turn the MODE switch to USB. Turn the CAL switch to 25K to turn on the calibrator. Set the BAND switch to 14 and tune the VFO to receive the calibrator's signal at 14.175 MHz.

On the IF board (See Figure 22) adjust T1 for a maximum S-meter reading. Then tune T2 and then T3, each for a maximum S-meter reading. Adjust the coils in the order described.

On the NB board (see Figure 20) adjust T6, T7, and T8 as described in the previous paragraph. Attach a DC voltmeter to TP5 and tune T4 and then T5 for a minimum voltage reading.

**CAUTION**

*Never adjust T1, T2, or T3 on the NB board.*

On the MIX board (see Figure 24) adjust coil T2 for a maximum S-meter reading. Turn the calibrator off when the adjustments are complete.

## 6.5 TRANSMITTER COIL PACK ALIGNMENT

**CAUTION**

*During transmitter adjustments, connect a 50 ohm dummy load to the ANT jack. Keep all transmitting periods as short as possible to avoid damaging the final tubes.*

Slide the SG switch (on the rear panel) to the OFF position, turn the MODE switch to TUN, and set the METER switch to the ALC position. The DRIVE control should be in the 12 o'clock position (white line pointed towards the top of the transceiver).

Adjust the DRIVE coils (See Figure 43) in the same order, and at the same frequencies, shown in Table 6. Set the BAND switch and VFO to the desired frequency for each coil. Adjust the coil for a maximum ALC deflection on the meter. If the ALC reading is too minimal to peak, adjust the DRIVE control slightly. If the ALC reading is still too minimal, turn the METER switch to IP, slide the SG switch to ON, and adjust the coil for maximum IP. Adjust each coil as described and when finished return the stand-by switch to REC.

**CAUTION**

*If tuning for maximum plate current, keep the transmit time as short as possible to prevent damage to the final tubes.*

## 6.6 CARRIER BALANCE

Use the following method to determine if the balanced modulator is out of balance.

Tune up the transceiver at 14.175 MHz (in the TUN mode) with a 50 ohm dummy load attached to the ANT jack. The SG switch should be in the ON position, the METER switch should be turned to RF, and the MODE switch should be placed at USB. Set the stand-by switch to SEND and turn the RF VOLT control fully clockwise for maximum sensitivity. If the balanced modulator is out of balance the RF meter reading will show output. The MIC GAIN control should be at its minimum setting during this procedure with no microphone connected.

Rebalance the modulator by adjusting TC1 and VR2 on the GEN board (See Figure 16) for a minimum RF setting on the meter.

## 6.7 TRANSMITTER NEUTRALIZATION

The TS-900 requires neutralization every time any of the three tubes are changed.

Tune up the TS-900 into a dummy load at 21.225 MHz for CW operation as described in Section 4.9. Set the SG switch to OFF and place a sensitive RF voltmeter across the dummy load. Flip the stand-by switch to SEND and adjust TC1 (see Figure 44) for a minimum reading on the voltmeter. After the final section is neutralized flip the stand-by switch to REC.

Slide the SG switch to ON and turn the driver's screen grid switch off. The switch is in the RF section, on the same board as the 6GK6 tube (See Figure 45). Switch the stand-by switch to SEND and adjust TC2 (driver board) for

a minimum reading on the voltmeter. When finished, turn the stand-by switch to REC and turn on the driver's screen grid.

A good receiver, tuned to 21.225, works very well for neutralizing if an RF voltmeter is not available. Instead of tuning for a minimum voltage, tune for a minimum S-meter reading.

**CAUTION**

*Neutralization of the final section should be carried out with the chassis shield in place. Dangerous high voltages are present in the final section when the transceiver is turned on.*

## 6.8 S-METER SENSITIVITY ADJUST

If the S-meter requires recalibration, set the BAND switch to 14, turn the noise blanker off, and turn the RF ATT control fully clockwise. With no antenna connected, set the zero adjust potentiometer, VR1 on the IF board (See Figure 22), for a reading of zero on the S-meter.

Apply a 14.3 MHz signal from a RF generator, accurately calibrated to produce a 50 $\mu$v signal, at the ANT jack. Peak the S-meter for a maximum reading by tuning in the signal with the main tuning dial and by adjusting the DRIVE control. Then adjust the sensitivity potentiometer, VR2 (see Figure 22), for an S-meter reading of S9.

## 6.9 VFO CALIBRATION

The VFO should be calibrated with the dial pointer calibrating lever. However, if the VFO is too far off calibration for the lever to work properly, there is an internal VFO adjustment.

Remove the TS-900's case and locate TC1 on the bottom of the VFO section (see Figure 47). Turn the CAL switch to 100K and tune the main tuning knob so that the dial pointer (when it is pointed straight towards the top of the transceiver) points to an even 100 KHz frequency. Adjust TC1 to zero beat the calibrator frequency.

## 6.10 CALIBRATING THE CRYSTAL CALIBRATOR

The crystal calibrator is factory adjusted and should need no further adjustment. If it should drift out of calibration, find TC1 on the VOX-MKR board (see Figure 30). Tune the receiver to WWV at 15 MHz and adjust TC1 until the calibrator signal is zero beat with the WWV 15 MHz frequency.

## 6.11 CARRIER AND ALC ADJUSTMENT

Tune and load the TS-900 at about 14.2 MHz into a 50 ohm dummy load. Locate VR2 on the MIX board (see Figure 24). Set the MODE switch to USB, the METER switch to ALC, and the stand-by switch to SEND. Make sure the MIC GAIN control is turned to its minimum. Adjust VR2 to zero the ALC meter reading. Then switch the stand-by switch back to REC.

Locate VR1 on the MIX board (see Figure 24). Leave the MODE switch in the CW position, leave the METER switch at ALC, and flip the stand-by switch to SEND. Key the transmitter and adjust the ALC sensitivity control (VR1) for an ALC meter reading of about ¼ of the ALC range. Set the stand-by switch back to REC when finished.

## 6.12 RIT ZERO

When the RIT circuit is turned on, and the RIT/XTAL control is set to zero, the receive frequency should be exactly the same as the transmit frequency. If the frequency is not the same, use the RIT zero control, VR2 on the CONT board. (See Figure 28).

To zero the RIT, turn on the calibrator and tune the VFO for about a 1000 Hz tone. Turn the RIT/XTAL control to zero. Turn on the RIT switch and adjust VR2 for the same 1000 Hz tone. Flip the RIT switch on and off to be sure the tones are identical.

## 6.13 BALANCED DETECTOR ADJUSTMENT

VR1 and TC2 on the generator (GEN) board (See Figure 16) are used to adjust the balanced product detector.

Tune the TS-900 for receiving at 14.2 MHz. Disconnect the antenna and place a high impedance RF probe at the non-grounded side of C16 on the GEN board. The voltage will be less than 50 mv. Adjust TC2 and VR1 for a minimum voltage reading. This should align the balanced detector.

## 6.14 AUDIO AMPLIFIER BIASING CURRENT

Remove the jumper between TP4 and the GND terminals on the AF board and replace it with a DC ammeter (0–0.3 amps). VR2 on the AF board (see Figure 26) should be adjusted for an idling current of 50 ma. When finished, replace the jumper.

**CAUTION**

*Excessive current can damage the AF amplifier.*

## 6.15 CLEANING the DIAL SCALE

Do not use chemicals to clean the dial scale because they will disolve the dye on the plastic scale. Usually warm water works well for removing dust or dirt.

## 6.16 ORDERING SPARE PARTS

When ordering replacement or spare parts for your equipment, be sure to specify the following information:

Model number and serial number of the equipment — Schematic number of the part — and the board number on which the part is located.

Should it ever be necessary to return the equipment for repair be sure to pack it very carefully and include a full description of the problems involved.

# SECTION 7. TROUBLESHOOTING

## 7.1 TRANSMITTER AND RECEIVER CIRCUITS

| SYMPTOMS | CAUSE | REMEDY |
|---|---|---|
| Pilot lights do not light and there is no receiver noise when the POWER switch is turned on. | 1 Bad power supply cable or bad power supply connections<br>2. Blown power supply fuse.<br>3. Wrong polarity connection with DS-900 | 1. Check cables and connections.<br>2. Replace the fuse<br>3. Check for a negative ground power connection |
| Frequency difference between transmit and receive.<br>FMing on sideband operation. | 1. 9 volt supply not adjusted.<br>2. Short circuit in 9 volt power supply or line.<br>3 Improper battery voltage in mobile or portable operation<br>4 RTTY jack shorted to chassis. | 1. See Section 6.3.<br>2. Check CAR-AVR board.<br>3 Check battery or alternator voltage.<br>4 Check RTTY jack and its wiring. |
| Dial pointer lamp does not light. | 1. Rear panel VFO switch is set to RMT.<br>2. CONT board not connected properly. | 1. Set the switch to INT.<br>2 Reseat CONT board. |
| Relays do not operate with the stand-by switch in the SEND position. | 1. Q8 on the VOX-MKR board is defective.<br>2 If only one relay does not operate, the relay is defective. | 1 Replace Q8.<br>2. Replace the bad relay. |
| The relays operate with the stand-by switch in the VOX position. | 1 Improper microphone connection. | 1. Rewire the microphone connector. |
| The dial calibrating lever will not move far enough to calibrate the dial scale. | 1. VFO requires internal calibration. | 1. See Section 6.9. |
| Signal reports of off frequency operation even though the dial scale is calibrated. | 1. Calibrator requires adjustment. | 1. See Section 6.10. |

## 7.2 RECEIVER SECTION

| SYMPTOMS | CAUSE | REMEDY |
|---|---|---|
| The AF GAIN control is turned fully clockwise and noises are heard, but no received signals or calibrator signals are heard. | 1. The VFO power plug or output cable is disconnected or open.<br>2 Defective diodes at the input/output of the IF board<br>3 Defective NB board or defective XF board. | 1. Check the VFO section.<br>2. Replace the diodes.<br>3. Check the boards. |
| CW filter is installed but selectivity and intelligibility are poor. | 1. Connector at the bottom of the XF board is reversed.<br>2 Bad CW filter. | 1. Check the polarity of the connector.<br>2 Replace the filter. |

| SYMPTOMS | CAUSE | REMEDY |
|---|---|---|
| An antenna is connected and the calibrator signal is received, but no signals are heard. | 1. The ANT switch is towards the REC ONLY jack.<br>2. RF ATT control is turned fully counterclockwise.<br>3 Bad T/R relay (RL2). | 1. Push the switch towards the SO-239 connector.<br>2. Turn the control fully clockwise.<br>3. Replace the relay |
| One or more bands are operating but some are not. | 1. The heterodyne oscillator is not operating on the defective band.<br>2. The ANT coil of the defective band requires alignment. | 1. See Section 6.2<br>2. See Section 6. 2. |
| Low AF volume or distorted AF. | 1. Balanced detector is out of adjustment.<br>2. AF board audio amplifier idling current requires adjustment. | 1. See Section 6.13.<br>2. See Section 6.14. |
| S-meter deflects without a received signal. | 1. Balanced detector is out of adjustment.<br>2 IF board is out of adjustment. | 1. See Section 6.13.<br>2. See Section 6 8. |
| S-meter reads too high or too low. | 1 IF board is out of adjustment. | 1. See Section 6.8. |
| RIT lamp lights when the RIT switch is turned on, but the RIT/XTAL control will not change the frequency. | 1 Defective or open two-prong connector on the VFO board.<br>2 Defective VFO board, | 1 Repair the connector.<br>2 Repair the board. |
| Lack of sensitivity on one or more bands. | 1 Receiver section requires alignment. | 1. See Section 6.2. |
| The RIT/XTAL control is at zero with the RIT circuit on, but the receive and transmit frequencies are different. | 1. The RIT control is out of adjustment. | 1. See Section 6.12. |

## 7.3 TRANSMITTER SECTION

| SYMPTOMS | CAUSE | REMEDY |
|---|---|---|
| T. MUTE lamp does not go off when the HEATER switch is turned off. | 1. SG switch is off. | 1. Slide the switch on. |
| ALC meter deflects with no output (no plate current). | 1. No high voltage (+800 v) on the final tubes.<br>2 Bad 6LQ6 tubes. | 1. Check the power supply output<br>2. Replace the tubes. |
| ALC meter does not deflect and there is no output. | 1. SG bias switch of the 6GK6 is turned off.<br>2. Defective circuits before the driver stage. | 1. See Section 6.7<br>2. Repair the circuit. |

| SYMPTOMS | CAUSE | REMEDY |
|---|---|---|
| | 3 HEATER switch and/or SG switch is turned off. | 3. Turn the switches on. |
| ALC meter does not deflect and there is output. | 1. Too little MIC GAIN.<br>2. ALC meter requires adjustment | 1. Increase MIC GAIN.<br>2. See Section 6.11. |
| The TS-900 will not operate on SSB | 1. Open microphone plug or bad microphone.<br>2. Too little MIC GAIN.<br>3. Defective microphone amplifier on the GEN board. | 1. Check the microphone.<br>2. Increase the MIC GAIN.<br>3. Repair the circuit. |
| There is output, but the RF meter shows no output. | 1. RF VOLT control not adjusted correctly.<br>2. Defective detector diode, D1, in the final section. | 1. See Section 4.7.<br>2. Replace the 1N60 diode. |
| RF meter deflects too far. | 1. RF VOLT control not adjusted correctly. | 1. See Section 4.7. |
| VOX does not operate. | 1. VOX GAIN control is closed.<br>2. Stand-by switch is in the REC or SEND position. | 1. See Section 4.8.<br>2. Set the stand-by switch to VOX. |
| VOX trips with AF sound from the speaker. | 1. ANTI VOX control requires adjustment. | 1. See Section 4.8. |
| VOX circuit releases between words or holds too long. | 1. VOX time hold control requires adjustment. | 1. See Section 4.8. |
| Excessive plate current. | 1. Detuned final section.<br>2 Low negative power supply voltage.<br>3. Idling current requires adjustment. | 1. See Section 6.7.<br>2. Check the power supply output.<br>3. See Section 4.7. |
| Plate current is too high or too low. | 1. Carrier requires adjustment. | 1. See Section 6.11. |
| FSK frequency shift is not correct. | | 1. See Section 6.3 |
| Low drive on one or more bands but not on all bands.<br>Broad DRIVE tuning on one or more bands but not on all bands. | 1. Transmitter section requires alignment. | 1. See Section 6.5. |
| No drive or intermittent drive on one or more bands. | 1. Heterodyne oscillator requires adjustment. | 1. See Section 6 2. |
| Low drive and broad DRIVE tuning on all bands. | 1 Bad 6GK6 driver tube | 1. Replace the tube. |

| SYMPTOMS | CAUSE | REMEDY |
|---|---|---|
| Signal reports of carrier. | 1. Carrier requires balancing. | 1. See Section 6.6. |
| Signal reports of distortion. | 1. Too much MIC GAIN. | 1. Reduce MIC GAIN. |
| Signal reports of tinny or bassy voice quality on sideband.<br>Low drive in CW but adjusting the carrier does not help. | 1. Carrier oscillator requires adjustment. | 1. See Section 6.3. |
| Plate current is too low.<br>Tuning becomes very broad.<br>Idling current increases. | 1 Bad final 6LQ6 tubes. | 1. Replace the tubes. |
| Every time any one of the three tubes is replaced, the TS-900 requires neutralization. | | 1. See Section 6.7. |

# VOLTAGE MEASUREMENTS(TABLE 8)

### Voltage Measurements of Tubes and IC's (In Volts)

| Unit | Pin No. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Final | V1, V2 6LQ6 | T | 131 | −46 | 0.03 | V1.12 | V1.6 | −46 | 131 | 0 | | 860 |
| | | R | 138 | −78 | 0 | V2 6 | V2 0 | 78 | 138 | 0 | | 890 |
| RF Unit | V1 6GK6 | T | 7 2 | 0 13 | 0 | 0 | 6.0 | – | 263 | 247 | 0 | |
| | | R | 0.74 | −48.5 | 0 | 0 | 6.0 | - | 308 | 308 | 0 | |
| NB Unit | Q8, Q9 TA7045M | R | 10 | 1.2 | 0 | 0.5 | 10 | 14 5 | 3.4 | 14.5 | | |
| CAR-AVR Unit | Q7 MFC4060A | R | 0 | 12.7 | 9.6 | 4.3 | | | | | | |

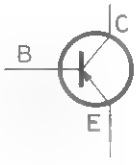
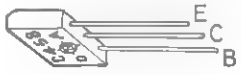
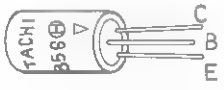
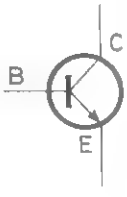
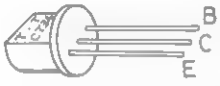
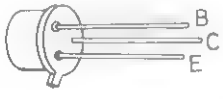
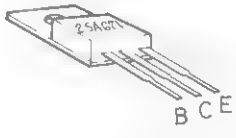
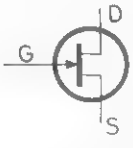
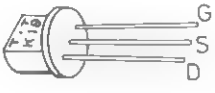
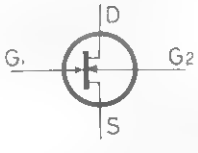
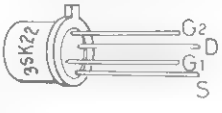
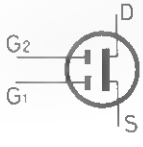
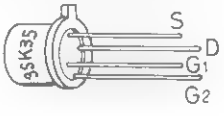
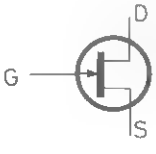
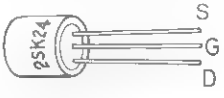
NOTES: 1. Voltage values obtained with the VTVM having 11 MΩ of input impedance
2. T. Maximum transmitting condition (CW). R: Reception with no input
3 The value in ( ) denotes the AC voltage and others are DC voltages.

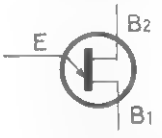
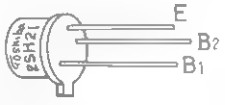
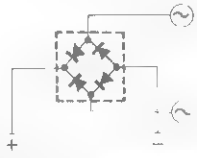
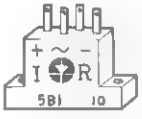
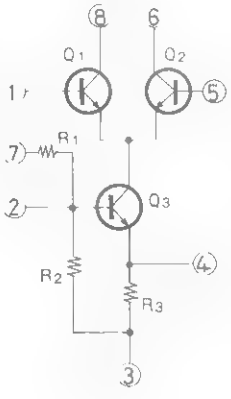
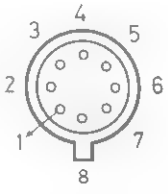
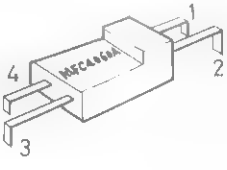
### Voltage Measurement of Transistors (In Volts)

| Unit | Transistor | | Emitter or source | Collector or drain | Base or 1st gate | 2nd gate |
|---|---|---|---|---|---|---|
| VFO | Q1 3SK22(Y) | R | 0 2 | 8.8 | 0 | 0 |
| | Q2 2SK19(Y) | R | 0.6 | 8 8 | 0 | |
| | Q3 2SC460(B) | R | 2.3 | 8.8 | 3 | |
| | Q4 2SC460(B) | R | 1.0 | 8.8 | 2.3 | |
| RF Unit | Q1 3SK35(BL) | T | 1.7 | 13.7 | 2.1 | 0 |
| | | R | 0 | 13.7 | −4.25 | −4.6 |
| | Q2 3SK35(GR) | T | 0 | 9.0 | −3.8 | −3.8 |
| | | R | 2.4 | 9.0 | 2.1 | 2.5 |
| | Q3 3SK35(GR) | T | 0 | 13.8 | 1.9 | 3.3 |
| | | R | 2.0 | 13.8 | 1.9 | 3.3 |
| Het OSC | Q1 2SK19(GR) | R | 1.3 | 8.9 | 0.1 | |
| | Q2 2SC460(B) | R | 2.6 | 8.9 | 3.2 | |
| | Q3 2SC460(B) | R | 1.9 | 8.9 | 2.6 | |
| Generator | Q1 2SK24(E) | T | 0.72 | 4.8 | 0 | |
| | | R | | | | |
| | Q2 2SC373 | T | 0.3 | 4.8 | 0 | |
| | | R | | | | |
| | Q3 2SC733(Y) | T | 1.09 | 4.0 | 1.7 | |
| | | R | | | | |
| | Q4 3SK35(GR) | T | 1.6 | 8.9 | 1.58 | 3.7 |
| | | R | 0 | 0 | 0 | 3.5 |
| N. B. | Q1 2SC374(BL) | R | 11.9 | 14.6 | 12.1 | |
| | Q2 2SC458(B) | R | 0 | 3.4 | 0.62 | |
| | Q3 2SC458(B) | R | 0 08 | 14.7 | 0.4 | |
| | Q4 2SA495(Y) | R | 14.4 | 1.8 | 14.5 | |
| | Q5 2SA495(Y) | R | 14.3 | 14.25 | 13.7 | |
| | Q6 2SA495(Y) | R | 5.1 | 0 | 3.7 | |
| | Q7 3SK35(GR) | R | 1.7 | 8.9 | 1.7 | 3.3 |
| Fixed Channel | Q1 2SC460(B) | R | 1.05 | 8.8 | 0.43 | |
| | Q2 2SC460(B) | R | 2.58 | 8.8 | 3.25 | |
| | Q3 2SC460(B) | R | 1.52 | 8.8 | 2.22 | |
| MIX | Q1 3SK35(GR) | T | 2.15 | 8.9 | −3 55 | 0 |
| | | R | 0 | 8.9 | 1 85 | 0 |
| | Q2 3SK35(GR) | T | 2.7 | 8.9 | 4.1 | 1.92 |
| | | R | 0 | 8.9 | 4.1 | −3.72 |
| | Q3 3SK35(GR) | T | 0 | 9.0 | −3.86 | 2.66 |
| | | R | 2.41 | 9.0 | 2.1 | 2 66 |
| | Q4 2SK19(GR) | T | 8.0 | 7.3 | 4.4 | |
| | | R | 8.1 | 7.3 | 4.4 | |
| | Q5 2SA495(Y) | T | 4.05 | 1.4 | 3.62 | |
| | | R | 4.09 | 2.71 | 3.65 | |
| | Q6 2SC373 | T | 3.50 | 8 8 | −1.3 | |
| | | R | 2.29 | 8 8 | 2.92 | |
| | Q7 2SA373 | T | −5.6 | 3.26 | 5.5 | |
| | | R | −5 6 | 3 27 | −5.6 | |
| | Q8 2SA562(Y) | T | 0 | −19.5 | −0.01 | |
| | | R | 0 | 19 5 | 0.01 | |
| | Q9 2SC374(BL) | T | −5.3 | 0 | 5.6 | |
| | | R | −5.3 | 0 | −5.6 | |
| IF | Q1 3SK35(GR) | T | 0 | 8.9 | −3 85 | 3.4 |
| | | R | 2.05 | 8.7 | 2.1 | 3.4 |
| | Q2 3SK35(GR) | T | 0 | 8.9 | −3.85 | 3.4 |
| | | R | 2.0 | 8.7 | 2.08 | 3.4 |
| | Q3 2SA495(Y) | T | 4.1 | 4.0 | 3.6 | |
| | | R | 3.8 | 0 06 | 3 45 | |
| | Q4 2SK19(GR) | T | 7.0 | 8.2 | 3.4 | |
| | | R | | | | |

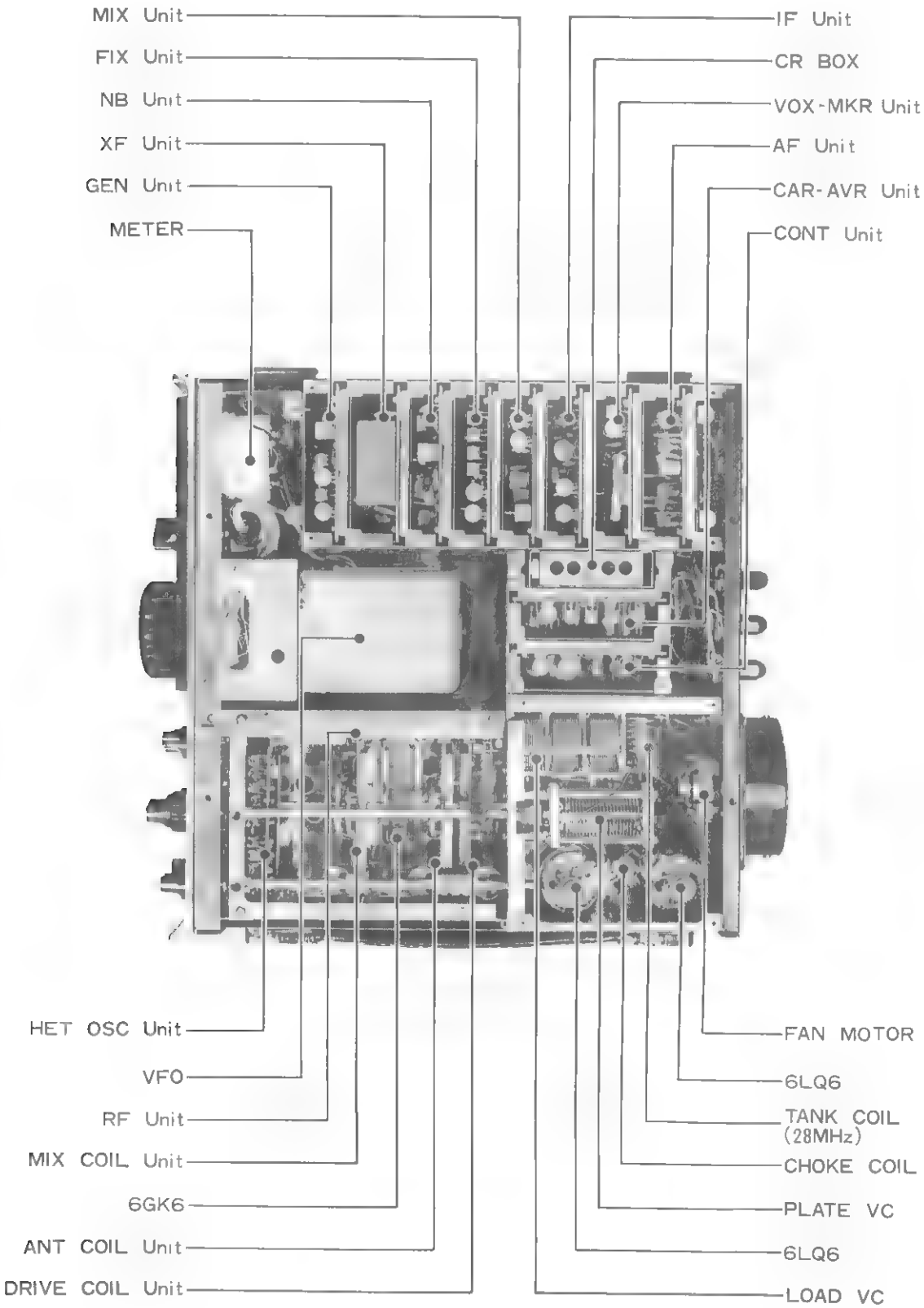
| Unit | Transistor | | Emitter or source | Collector or drain | Base or 1st gate | 2nd gate |
|---|---|---|---|---|---|---|
| | Q5 2SC733(Y) | T | 0.65 | 8.8 | 1 23 | |
| | | R | | | | |
| | Q6 2SC373 | T | −6.4 | 3 42 | −6.1 | |
| | | R | | | | |
| VOX/MKR | Q1 2SC373 | T | 0 | 0.14 | 0.66 | |
| | | R | | | | |
| | Q2 2SC373 | T | 0 | 0 | 0.07 | |
| | | R | | | | |
| | Q3 2SC373 | T | 0.6 | 5.6 | 1.21 | |
| | | R | | | | |
| | Q4 2SC373 | T | 0 | 6.9 | 0 | |
| | | R | | | | |
| | Q5 2SA562(Y) | T | 6.4 | 0 | 7.0 | |
| | | R | | | | |
| | Q6 2SC373 | T | 5.3 | 6.25 | 5.8 | |
| | | R | 5.25 | 5 9 | 5.8 | |
| | Q7 2SC373 | T | 5.3 | 11.7 | 3 75 | |
| | | R | 5.25 | 15.0 | 0 | |
| | Q8 2SA497(Y) | T | 12.9 | 12.8 | 13.5 | |
| | | R | 15.5 | 0 | 15 | |
| | Q9 2SC373 | T | 0.03 | 9.0 | 0.62 | |
| | | R | | | | |
| | Q10 2SC373 | T | 0 | 2.1 | 0.52 | |
| | | R | | | | |
| | Q11 2SC373 | T | 0 | 6.3 | −0.52 | |
| | | R | | | | |
| | Q12 2SC373 | T | 0 | 8.2 | −0.1 | |
| | | R | | | | |
| | Q13 2SC373 | T | 4.05 | 9.0 | 4.7 | |
| | | R | | | | |
| AF | Q1 2SC733(O) | R | 4.2 | 8.9 | 4.9 | |
| | Q2 2SC733(O) | R | 1.07 | 7.4 | 1.7 | |
| | Q3 2SC373 | T | 0 | 8.9 | 0 | |
| | | R | | | | |
| | Q4 2SC373 | R | 2.2 | 4.85 | 2.9 | |
| | Q5 2SC734(Y) | R | 0.67 | 7.0 | 1.3 | |
| | Q6 2SC1061(A) | R | 7.7 | 14.7 | 8.3 | |
| | Q7 2SA671(A) | R | 7.7 | 0 | 7.0 | |
| CAR/AVR | Q1 2SC460(B) | R | 0.8 | 8.9 | 1.4 | |
| | Q2 2SC460(B) | R | 1.3 | 8.9 | 2.0 | |
| | Q3 2SC373 | R | 12.7 | 13.8 | 13.3 | |
| | Q4 2SC373 | R | 9.0 | 13.4 | 1 6 | |
| | Q5 2SA495(Y) | R | 1.4 | 1.6 | 9 | |
| | Q6 2SD234(O) | R | 9.0 | 15.5 | 9.6 | |
| | Q8 2SC373 | R | 0 | 8.2 | 0 | |
| | Q9 2SC374(BL) | R | 0 | 0 11 | 0 | |
| | Q10 2SC735(Y) | R | 0 | 0 | 0 | |
| Control Unit | Q1 2SC856 | T | -41 | 2 5 | −41 | |
| | | R | 70 | 4 4 | −70 | |
| | Q2 2SC735(Y) | T | 0 | 0.23 | 0.76 | |
| | | R | | | | |
| | Q3 2SC458(B) | T | 0.26 | 7.4 | 0.91 | |
| | | R | | | | |
| | Q4 2SA495(Y) | T | 0 | 0 74 | 1 92 | |
| | | R | 0 | −0 06 | −0.64 | |
| | Q5 2SA429(Y) | T | 0 | −0.74 | −0.73 | |
| | | R | 0 | −0.06 | −0 06 | |

# TRANSISTOR BASE DIAGRAM(TABLE 9)

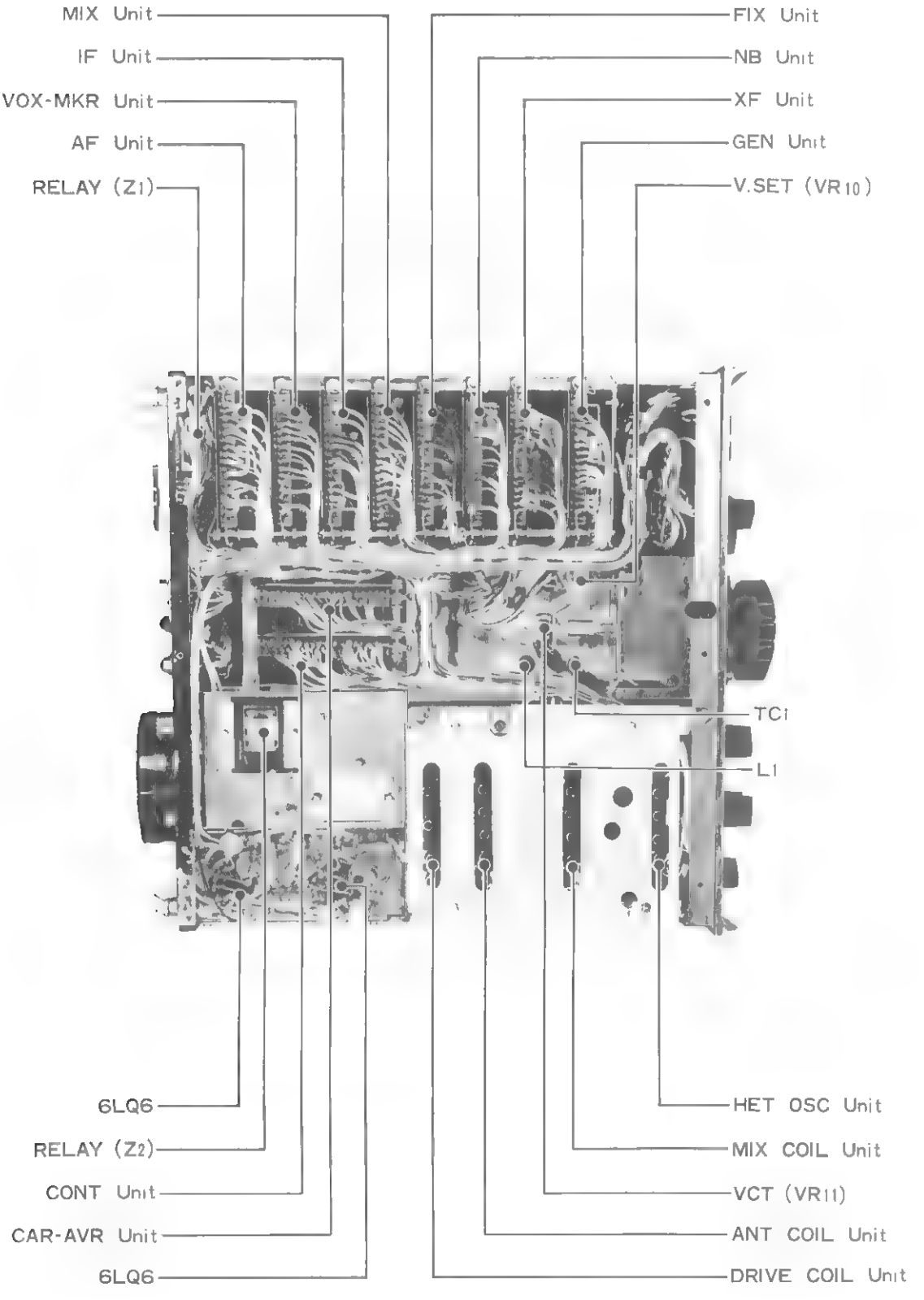
| SYMBOL | SHAPE | MODEL |
|---|---|---|
| (PNP)   |   | 2SC460<br>2SC458 |
| |   | 2SC856 |
| (NPN)   |   | 2SA429<br>2SA495<br>2SA562<br>2SC373<br>2SC374<br>2SC733<br>2SC734<br>2SC735 |
| |   | 2SA497 |
| |   | 2SA671<br>2SC1061<br>2SD234 |
|   |   | 2SK19 |
|   |   | 3SK22 |
|   |   | 3SK35 |
|   |   | 2SK24 |

| SYMBOL | SHAPE | MODEL |
|---|---|---|
|   |   | 2SH21 |
|  |   | 5B1 |
|   |   | TA-7045 |
| |   | MFC4060A |
| Cathode Anode | Cathode (Marked in Color Specified) | V08J : Green<br>V08J Red<br>V06B: Yellow |
| | Cathode (Marked in Color Specified) | IOD1 · White<br>RV-1 Blue |
| | Cathode | .S73A IN60<br>.S1555 SD111<br>IS1658-②<br>WZ-090<br>MZ1004<br>DZ-140 |

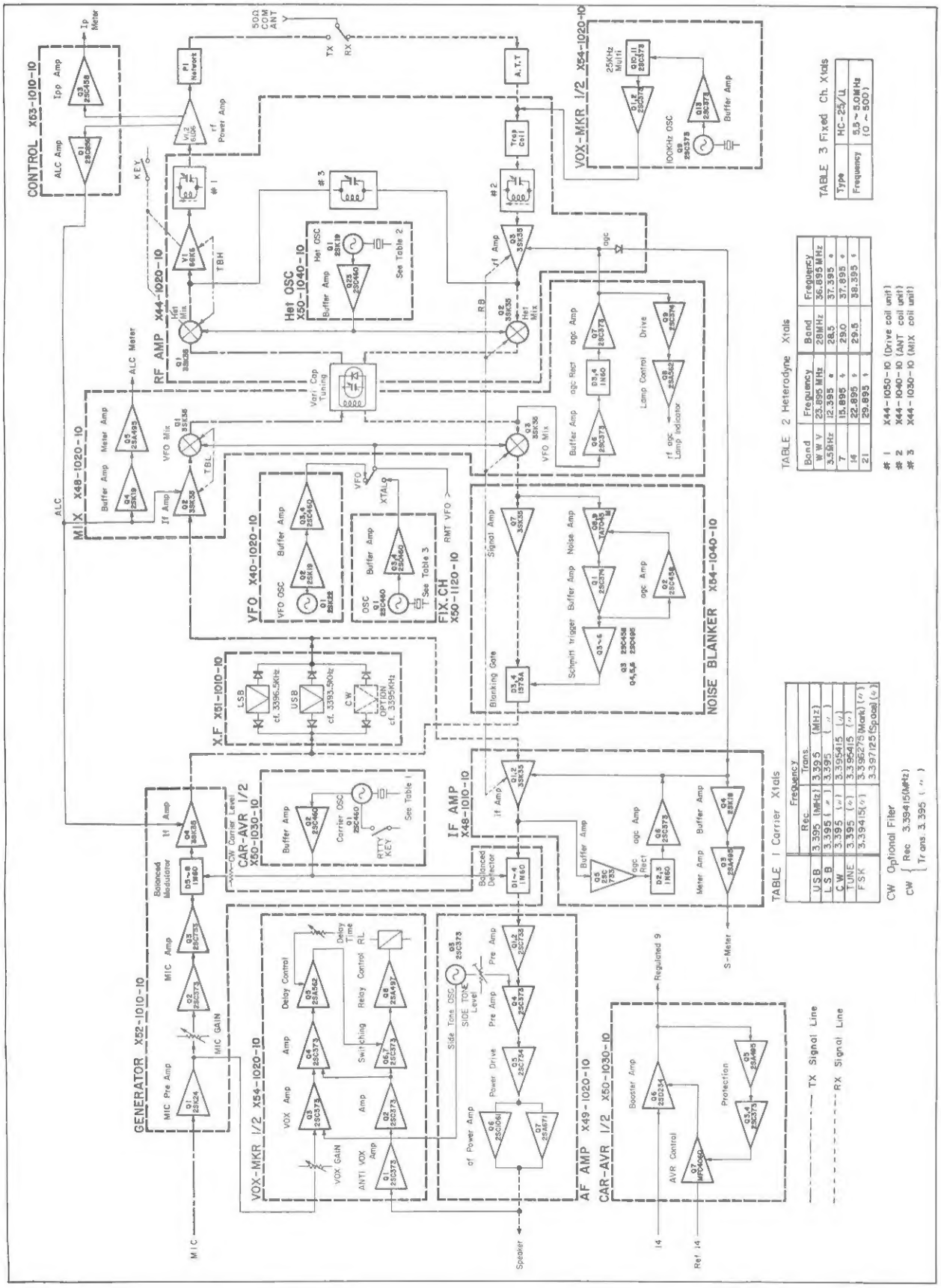
# TOP VIEW OF THE TS-900(FIGURE 46)



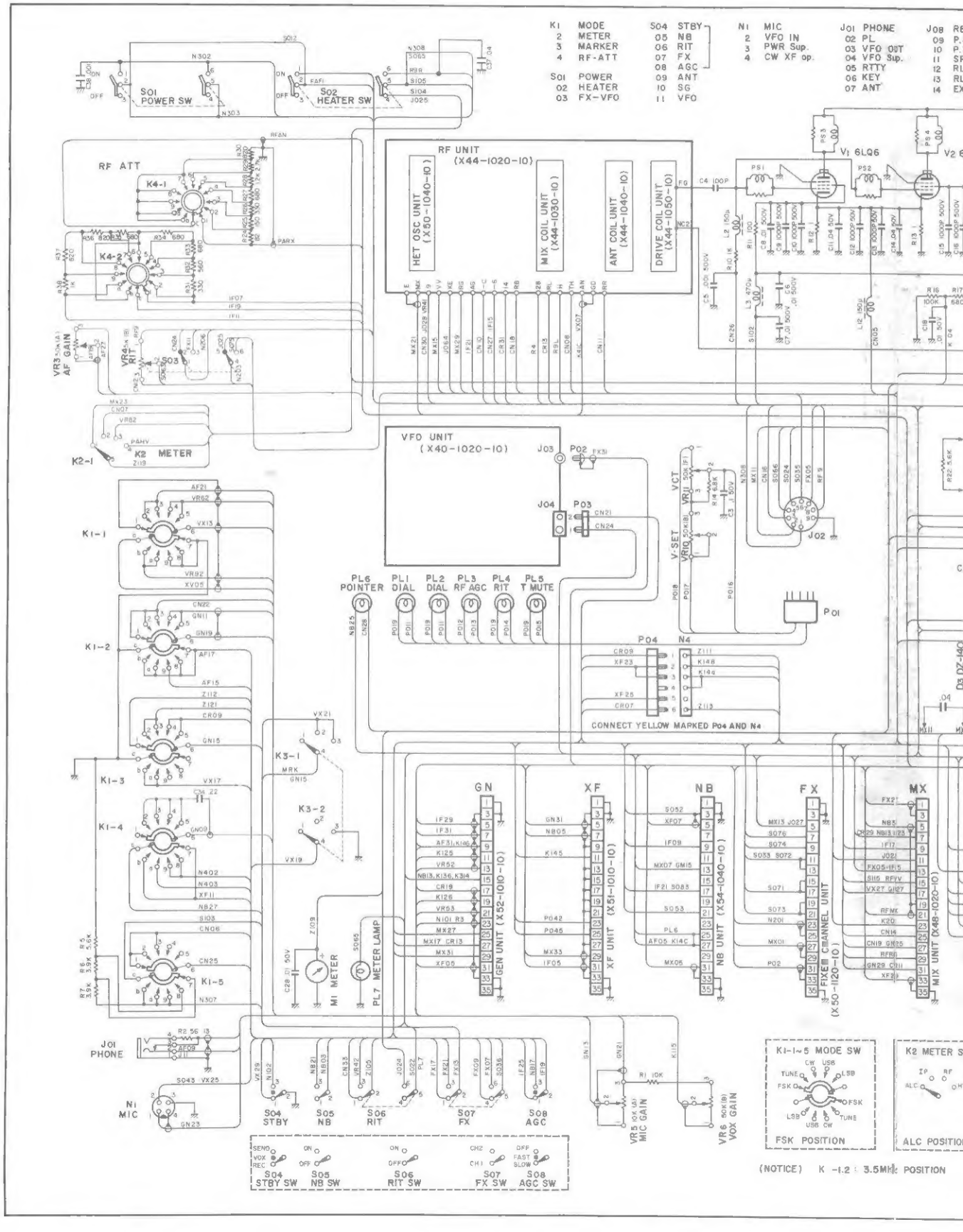
# BOTTOM VIEW OF THE TS-900(FIGURE 47)



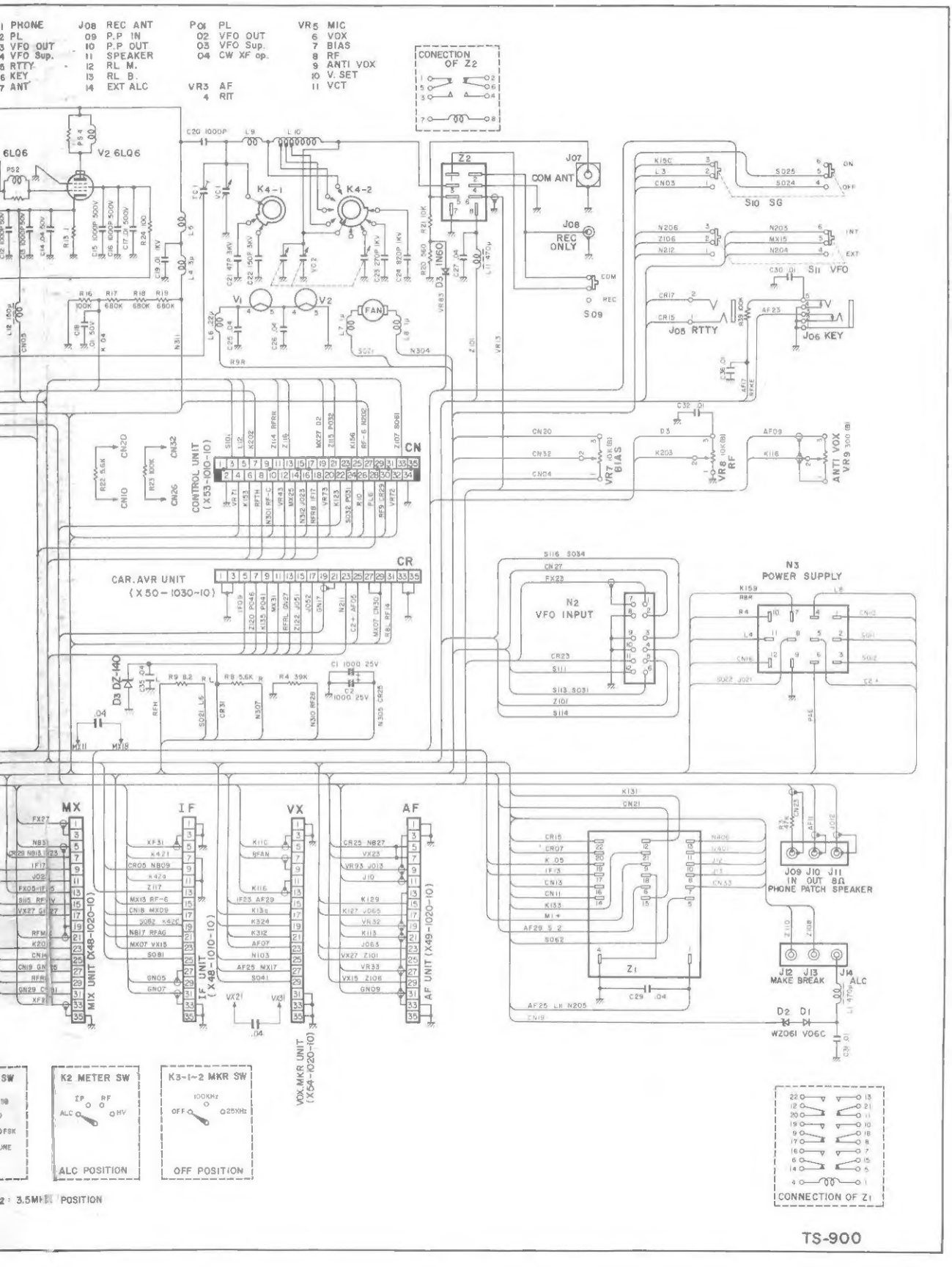
# TS-900 BLOCK DIAGRAM(FIGURE 48)



# TS-900 SCHEMATIC(



# MATIC(FIGURE 49)



KENWOOD

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